STANFORD BIO-X UNDERGRADUATE SUMMER RESEARCH PROGRAM

STANFORD BIO-X

"There is no question that the Bio-X grant was a key facilitator of my professional success. Particularly because I was a first-generation college goer, I really needed that extra time with Dr. Schnitzer and his group to learn about academic and research culture."

—2005 USRP Participant Allison Waters, now an Assistant Professor of Psychiatry and Neuroscience at Mount Sinai

STANFORD BIO-X
UNDERGRADUATE SUMMER RESEARCH PROGRAM

2023 Undergraduate Summer Research Program (USRP) Participants

In Summer 2024, the Stanford Bio-X Undergraduate Summer Research Program enthusiastically welcomed our full cohort of **76** exceptional Stanford students to research in laboratories across the campus. Since 2006, Stanford Bio-X has provided a ten-week summer research opportunity to a total of **1,002** students.

With the goal of creating a vigorous, valuable, and fulfilling in-person research experience to fast-track the sharpening of students' skills and techniques, 49 Faculty, Bio-X postdocs, graduate students, researchers, Bio-X USRP alums, and senior-level undergraduates from 29 departments and the Stanford Bio-X Institute contributed their time and effort to the talks, workshops, journal clubs, and other events that enriched the **20th year** of the Stanford Bio-X Undergraduate Summer Research Program.

These members of the Bio-X community helped to facilitate fulfilling new connections and networks and to enrich the students' learning experience. Structured components of the program include:

30 Faculty Talks (3 talks each Wednesday during the 10-week program), see pages 6-7:
These talks expose students to a variety of scientific fields and enrich their summer interdisciplinary research experience. Faculty share their personal academic journeys as well as their research with students, providing them the opportunity to hear more about the broad range of research within Stanford. Students meet faculty in a variety of scientific fields and have the chance to network with each other as potential future collaborators and colleagues at the lunches hosted by the Stanford Bio-X Institute after the talks.

4 Workshops (offered in the spring and summer quarters), see page 43:
Throughout the program, workshops explore research-related skills to prepare for, and enrich, the ten-week immersive experience. These workshops include how to analyze scientific manuscripts, mastering research design, how to give oral presentations, and poster design. In addition to the undergraduate cohort receiving valuable training, the Bio-X community members who develop these workshops gain the opportunity to practice their teaching and presentation skills. The workshops also become a resource for the summer cohort for broader career and research advice by expanding their network of colleagues at Stanford.

5-Week Journal Club Series (10 groups exploring different topics), see pages 44-45:
The journal club series facilitates critical thinking among the students as they work in small groups to lead intellectually rigorous discussions regarding recent publications, innovations, and challenging scientific problems. Reading, understanding, and sharing insights from published manuscripts is a critical part of involvement in any research community, and practicing these skills during the Undergraduate Summer Research Program will serve these bright young researchers well as they continue their research careers. Like the workshops, this educational program also offers the postdocs, graduate students, and researchers leading the clubs a unique opportunity to develop their teaching skills, share their research insights, improve their mentorship capabilities, and expand their interactions with undergraduate students, enhancing their own career development as well as the student cohort's summer experience.

Professional Networking Events, see page 46-47:
Recognizing that our undergrads who confirm their love of research this summer are already contemplating what is next, the Bio-X Institute hosts events that spark ideas about what is possible post-graduation for this cohort of bright and talented students. The Bio-X USRP alumni continue to do remarkable things in medicine, academia, and industry. To provide an opportunity to network and educate, three former students—a double board-certified adult psychiatry and child & adolescent psychiatrist, a professor at Stanford, and an MBA grad currently engaged in public equities across several sectors—discuss and answer questions about their professional journeys during a panel discussion. Separately, ten of our Bio-X PhD fellows on various PhD and MD paths are invited to have breakfast with our cohort, sharing their experiences on everything from preparing for the MCATs, deciding on an area of research and finding the right lab, to thriving in grad school.

Poster Session, see page 47:
At the conclusion of the program, students apply the different skills they learned from Bio-X workshops and throughout the program to create and present a scientific poster summarizing the results of their summer research. This highly-attended event also allows students to discover new fields, learn about the breadth of work supported by the program, and network with colleagues, faculty members, and even professionals from other fields, as well as refining their skills at visual and verbal research presentation.

Stanford Bio-X remains committed to fostering a strong interdisciplinary training for these up-and-coming scientists and ensuring that each of our undergrads has a fulfilling summer which enhances their research skills and helps prepare them for future careers in science and medicine.

Funding for the support of our program was provided by generous contributions from The Rose Hills Foundation, Kath Lavidge and Ed McKinley, Herald and Linda Ritch, Stanford Bio-X, Dr. Carla Shatz, Owen and Jane Frost, Everett and Jie Frost, and Anonymous Donors.

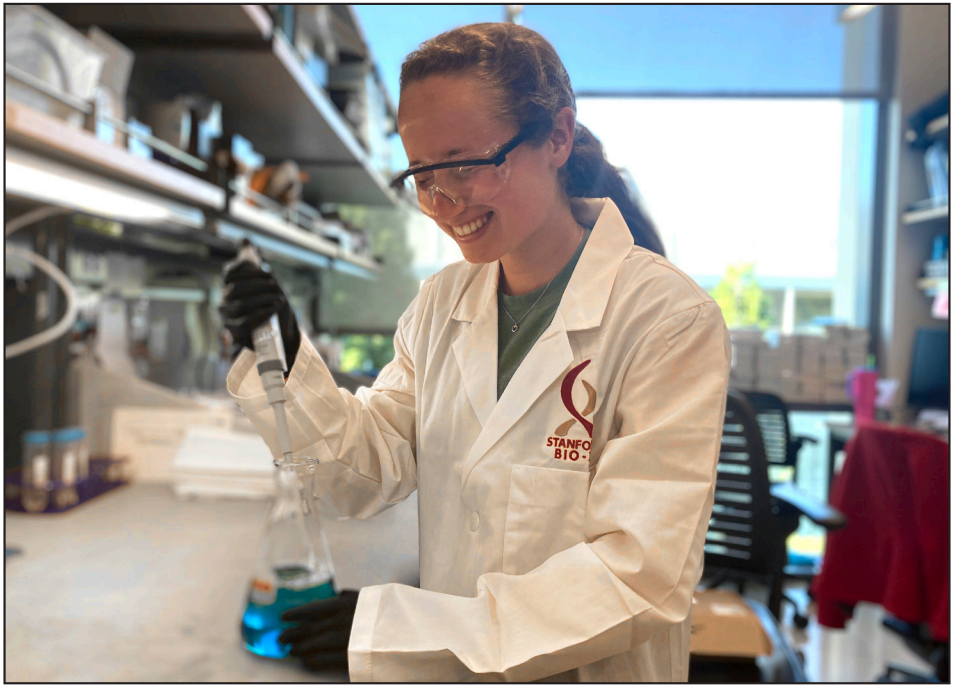
2015 Undergraduate Summer Research Program (USRP) Participants

Stanford Bio-X Undergraduate Summer Research Program Alumni:

Countless students who have participated in the Stanford Bio-X Undergraduate Summer Research Program have indicated that the experience changed the course of their time at Stanford and influenced their future careers. Alumni of the program are extremely successful. They have gone on to:

- pursue doctorates and medical degrees all over the world, at dozens of institutions
- become faculty members in the sciences at leading universities and hospitals
- publish in high-impact journals including *Cell*, *Science*, *Nature*, *Nature Medicine*, *Neuron*, *PNAS*, and dozens more
- receive awards and scholarships like NSF Graduate Fellowships, the Rhodes Scholarship, the Churchill Scholarship, the Gates Cambridge Scholarship, the Soros Fellowship for New Americans, the David M. Kennedy Honors Thesis Prize, the Firestone Medal for Excellence in Undergraduate Research, and countless others
- accept exciting positions in industry and beyond, at dozens of biotech, pharmaceutical, and healthcare companies
- start their own companies, including NeuCures, THEON Therapeutics, shimmer, Kinsol, Y-Trap, Diffeo, Taste, Epitoire Biosciences, Fancy That, Benchling, Stronger Brains, and many other innovative startups and non-profits at the intersection of science, technology, and health

2021 and 2022 USRP Participant Isaac Applebaum's research with Drs. Robert M. Waymouth, Grant Rotskoff, and Ronald Levy used machine learning to design polymers for gene delivery, with implications for mRNA-based vaccines and cancer immunotherapy. Isaac is now a Corporate Development Analyst at Kriya Therapeutics, a biotech startup developing innovative gene therapies.



Alexandra Midler completed her Stanford Bio-X summer research training with Dr. Michelle Monje

Stanford Bio-X Undergraduate Summer Research Program Alumni:

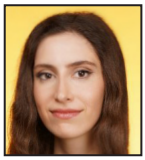
2022 Undergraduate Summer Research Program (USRP) Participants

Leila Yeh Beach, 2008 cohort (left), is an Assistant Professor of Medicine at the University of California, San Francisco, and a practicing cardiologist specializing in advanced heart failure. Leila earned her MD from UCSF in 2014 and also completed her residency there. She is a member of the UCSF Women in Cardiology group, an organization established to share experiences, foster peer mentorship, and advocate for cultural change, and to engage and promote women in leadership and build a community of support. Leila has published in JAMA Internal Medicine, Circulation, The American Journal of Cardiology, and more.

Cameron Pitt, 2008 cohort (right), is the Chief Operating Officer and Board Member of Quanta Therapeutics, a group that is developing best-in-class allosteric inhibitors for RAS-driven cancers and leading the Next Wave of Innovation in KRAS Therapy. Cameron received his PhD in Biomedical Sciences from the University of California, San Francisco. He credits his early work experiences in the Bio-X USRP as critical preparation for his PhD in biomedical sciences and helping launch his career in biotech.

Dakin Sloss, 2009 cohort (left), is an entrepreneur, investor, and philanthropist. He is Founder and General Partner of Prime Movers Lab, the world's leading partner of breakthrough scientific startups. He has led investments in transformative companies including Momentus, Heliogen, Vaxxinity, Tarana, Upward Farms, Focused Energy, Gilgamesh, Boom, and Carbon Capture. Dakin is also a philanthropist dedicated to ending world hunger, resolving the global mental health pandemic, and redesigning early childhood education to cultivate integrated beings across body, mind and spirit. Dakin has been recognized by Yahoo! Finance's THE NEXT: 21 people who will have a significant impact on the worlds of finance, business, sports or politics, Forbes 30 Under 30, and San Francisco Business Times 40 Under 40.

Jake Wang, 2011 cohort (right), is an Assistant Professor in the Department of Dermatology at Case Western Reserve University School of Medicine and specializes in Mohs surgery at University Hospitals in Cleveland, Ohio. Jake completed medical school, residency, and fellowship at the Yale School of Medicine. His interests include rare cutaneous sarcomas and the management of aggressive skin cancer in immunosuppressed populations. He is a member of the American College of Mohs Surgery and the International Immunosuppression & Transplant Skin Cancer Collaborative.



Sona Sulakian, 2015 cohort (left), is a practiced attorney with expertise in transactional law and intellectual property. She has a background as a strategic consultant in legal tech, where she helped companies automate their internal processes for almost three years. She is co-founder and co-CEO of Pincites, which reduces the time legal teams spend on contract negotiation while achieving better, more consistent results using the latest large language models, integrating computer science and AI with legal contracts. Sona was also the winner of the 2022 Entertainment Law Initiative Writing Contest.

Ashley Westerfield, 2017 cohort (right), Ashley Westerfield is a PhD student in the Health Sciences and Technology department at MIT. She is also a National Science Foundation Graduate Research Fellow and an Alfred P. Sloan 2020-21 Scholar. Her USRP research prepared her for an internship at Genentech, a summer at the Broad Institute, and additional research at Stanford on 3D bioprinting before starting her PhD at MIT. Ashley's current reserch with Dr. Sangeeta Bhatia involves engineering micro- and nanotechnologies to address complex challenges ranging from cancer to liver disease and acquired infections. Ashley is also passionate about mentoring diverse and underrepresented students in STEM.

2024 Faculty Talks:

June 26

Daniel Palanker (Ophthalmology), "Photovoltaic Restoration of Sight in Retinal Degeneration"
Naima Sharaf (Biology), "Lipoproteins of Gram-Negative Bacteria"
Ron Kopito (Biology), "Quality Control"

July 3

Ayelet Voskoboynik (Biology), "*Botryllus schlosseri*, a Model Organism for the Study of the Evolution of Stem Cell Mediated Regeneration and Self/Non Self Recognition"
Danielle Mai (Chemical Engineering), "Enzyme-Driven Phase Changes of Elastin-Like Polypeptides"
Carolyn Rodriguez (Psychiatry & Behavioral Sciences - Public Mental Health & Population Sciences), "Mechanisms and Modulation of Compulsive Behaviors"

July 10

Lauren Goins (Developmental Biology), "Studying Blood Cell Development Live and in Color!"
Scott Owen (Neurosurgery), "Neuromodulation of Cognitive Function in the Basal Ganglia"
Justin Annes (Medicine - Endocrinology), "Physician Scientist Endo(Onc)ology: From Animal Disease Models to Drug Development"

July 17

Judith Shizuru (Medicine - Blood & Marrow Transplantation), "Blood Stem Cell Transplantation"
Michelle Monje (Neurology & Neurological Sciences), "The Neuroscience of Brain Cancer"
Brad Zuchero (Neurosurgery), "What Do Glia Do? An Intro to My Favorite Cell Types"

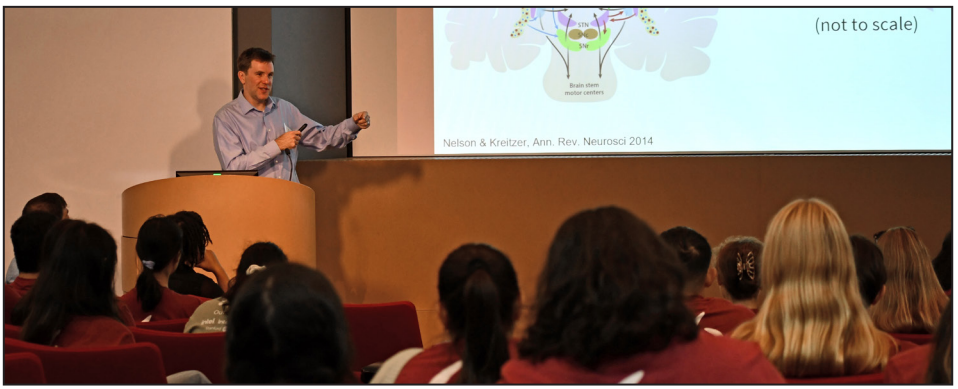
Lauren Goins,
Assistant Professor of Developmental Biology

July 24

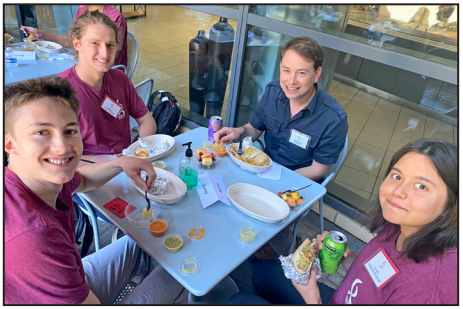
Lucy O'Brien (Molecular & Cellular Physiology), "Building an Organ for the Long Haul: Theseus' Paradox, One Cell at a Time"
Jeffrey L. Goldberg (Ophthalmology), "Neuroprotection: Bench to Clinic"
E.J. Chichilnisky (Neurosurgery and Ophthalmology), "High-Fidelity Artificial Retina for Vision Restoration, Science, and Augmentation"

July 31

Helen Blau (Microbiology & Immunology - Baxter Laboratory), "Targeting a Gerozyme to Improve Muscle Function and Extend Healthspan"
Vivek P. Buch (Neurosurgery), "Developing the Surgeon-Machine Interface"
Jason Tucciarone (Psychiatry & Behavioral Sciences - General Psychiatry & Psychology), "Uncovering Novel Mechanisms Leading to Opioid Withdrawal"



Scott Owen, Assistant Professor of Neurosurgery



2024 USRP participants Max Scherer, Sybren van den Bedem, and Irenka Saffarian-Deemyad enjoying lunch with Dr. Brad Zuchero

2024 USRP participants Binta Diallo, Nicholas Neoman, and Gwendolyne Aguilar enjoying lunch with Dr. Judith Shiruzu

August 7

Craig Levin (Radiology - Molecular Imaging Program at Stanford/Nuclear Medicine), "Biological Multiplexing with Positron Emission Tomography"

William Talbot (Developmental Biology), "Using Zebrafish to Investigate the Vertebrate Nervous System"

Crystal Mackall (Pediatrics - Hematology & Oncology and Medicine - Blood & Marrow Transplantation), "Developing CAR T Cells for Cancer"

August 14

Yanmin Yang (Neurology & Neurological Sciences), "Targeting Tau Propagation in Alzheimer's Disease"

Nidhi Bhutani (Orthopaedic Surgery), "Epigenetic Regulation of Cell Fate and Function"

Laura Prolo (Neurosurgery), "Circadian Rhythms in Pediatric High-Grade Gliomas"

August 21

Thomas Clandinin (Neurobiology), "How Does the Brain Guide Behavior?"

Claudia Padula (Psychiatry & Behavioral Sciences - Public Mental Health & Population Sciences), "Neuromodulation of Brain Circuits Implicated in Addiction"

Paul Cheng (Medicine - Cardiovascular Medicine), "From Big Data to Single Cells – Unlocking Pathophysiology from Human Variations"

August 28

Zev Bryant (Bioengineering), "Making, Measuring, and Modeling Macromolecular Machines"

Rogelio Hernández-López (Bioengineering and Genetics), "Engineering T Cells to Kill Cancer"

Sarah Heilshorn (Materials Science & Engineering), "Designer Materials for Tissue Engineering"

Daniel Palanker,
Director of the Hansen Experimental Physics Laboratory and Professor of Ophthalmology

Lucy O'Brien,
Associate Professor of Molecular & Cellular Physiology

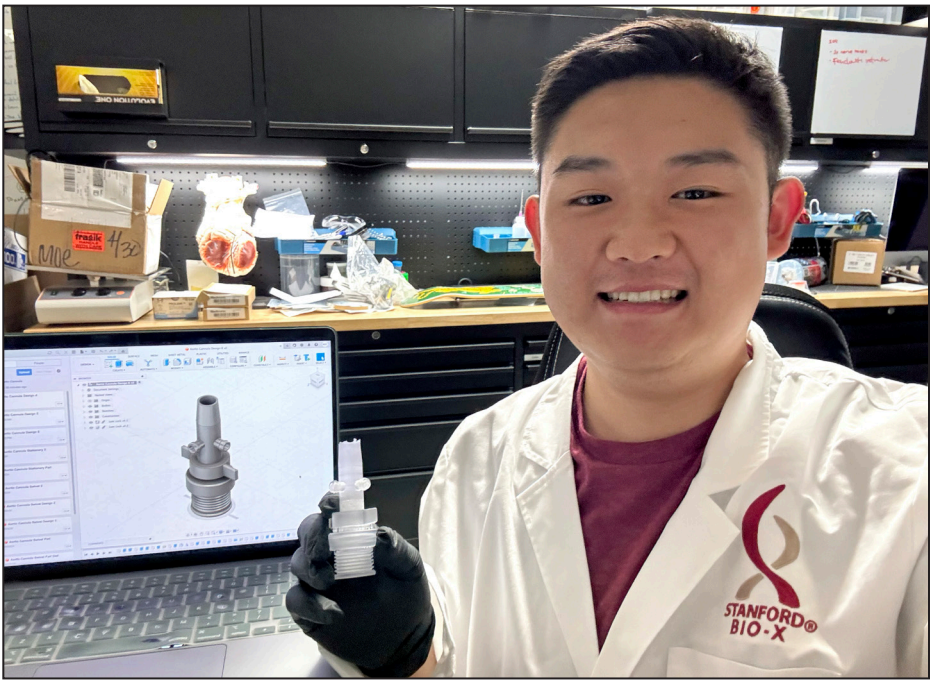
"The Wednesday speaker sessions truly opened my eyes to so many different paths through research and subfields of research. Hearing how passionate these PIs were made me truly excited about the endless possibilities this field has."

—2023 USRP Participant Gwendolyn Donahue

2024 Stanford Bio-X Undergraduate Summer Research Program Participants:

Aaron Adam, Biology
Mentor: Jennifer Raymond (Neurobiology)
Optogenetic Manipulation of Purkinje Cells to Evaluate Cerebellar Contribution to Oculomotor Integration in Mice
Many brain functions require information be accumulated and stored (including perception, decision making, walking, and more), through a process that can be conceived as a mathematical integration. Aaron is investigating how a brain area called the cerebellum contributes to this process by studying eye movements. The neural commands controlling eye movements need to be integrated to hold the eye position steady between movements. Aaron is analyzing how silencing the output of the cerebellum alters this neural computation and its ability to be adaptively calibrated through experience.

Gwendolyne Aguilar, undeclared
Mentor: Jason Tucciarone (Psychiatry & Behavioral Sciences)
Uncovering Neural Ensembles in Opioid Intoxication and Precipitated Withdrawal
As the opioid epidemic remains a devastating reality in America, with more than 100,000 overdose-related deaths annually, it is vital to find new treatment options. Understanding the neurobiological mechanisms and circuits of opioid intoxication and withdrawal will be important to uncover new therapeutic targets. Gwendolyne will use cutting edge molecular and genetic neuroanatomical tools to uncover circuits and cell type ensembles recruited during opioid intoxication and precipitated withdrawal. The lab hypothesizes that segregated circuitry in the brain's reward pathways will mediate both drug states and will be an entry point for further studies uncovering mechanisms of compulsive use and drug relapse.



Matthew Kim completed his Stanford Bio-X summer research training with Dr. Joseph Shrager

2019 Undergraduate Summer Research Program (USRP) Participants

Anna Amine, undeclared
Mentor: Bianxiao Cui (Chemistry)
Development of a Microfluidics Platform for Elucidating Cell-ECM Interactions: Investigating Integrin-Mediated Adhesions in Disease Pathogenesis

The extracellular matrix (ECM), a network composed of proteins, is crucial for cell adhesion, migration, and signaling. Cell-ECM interactions are pivotal for human health, as impaired interactions can influence the progression of diseases like cancer and fibrosis in developing tumors and organ malfunction. Anna's summer project focuses on creating an advanced microfluidics platform to study a new form of integrin-mediated adhesions and investigate the effects of blocking these curved adhesions in cancer cells. Anna aims to uncover new insights in the cellular behaviors within the ECM, leading to breakthroughs in the treatment of disease pathologies driven by abnormal Cell-ECM dynamics.

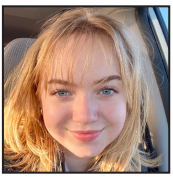
Eli Andino-Frydman, undeclared
Mentor: Wah Chiu (Bioengineering, Microbiology & Immunology)
Studying Protein Synthesis and Folding Under Huntington's Disease in iPSC-Derived Neurons and Mouse Primary Neurons Using Cryogenic-Electron Tomography

Huntington's Disease (HD) is a fatal, incurable neurodegenerative disorder – manifesting in cognitive and motor impairment – caused by a mutated Huntingtin protein (mHTT) with an expanded polyglutamine tract. mHTT forms toxic aggregates and inclusions. Structural biology studies have primarily focused on mHTT aggregate morphology and organelle dysfunction. However, HD has been shown to cause translation and proteostasis disruptions. Eli will use cryogenic-electron tomography to investigate how mHTT affects translation and chaperones *in-situ* in neuronal HD models. His project will determine the distribution of translation states and chaperonin conformations under mHTT stress. Identifying biomarkers of HD is essential for developing diagnostics and treatments.

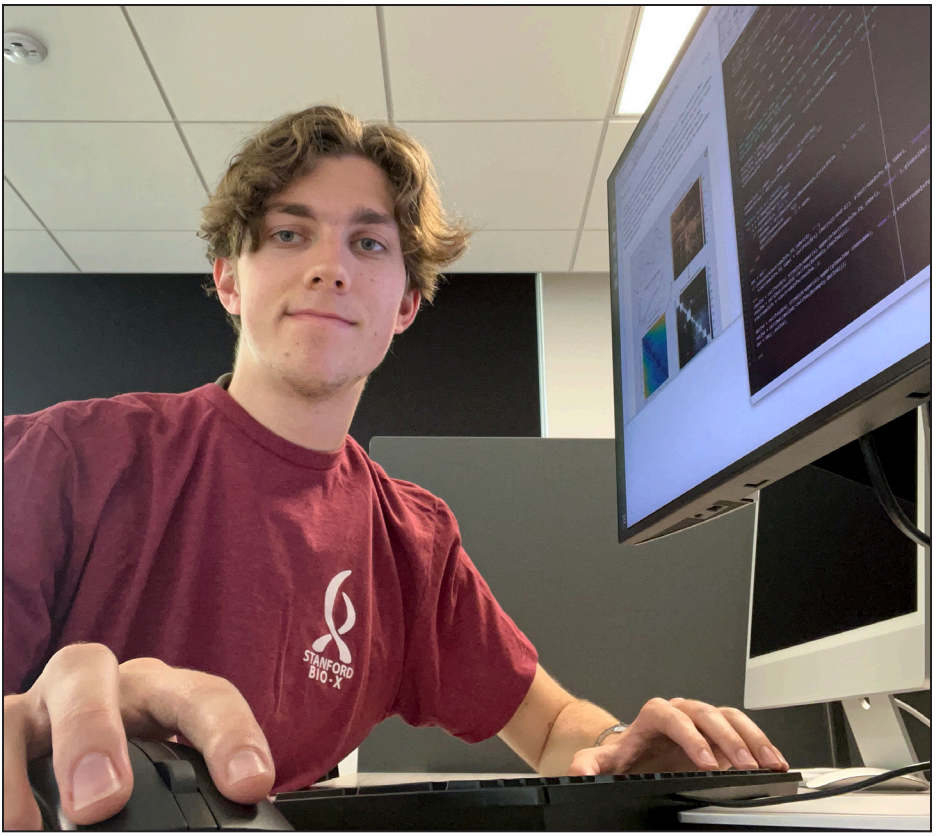
Marc Arslanian, Biology
Mentor: Naima Sharaf (Biology)
Using Lipoprotein Based Nanoparticles to Solubilize Hydrophobic and Hydrophilic Biomolecules

Marc has been working in the Sharaf Lab for nearly two years, exploring how bacterial lipoproteins can associate with and carry both hydrophobic (water-repelling) and hydrophilic (water-loving) molecules. Moving forward, he plans on characterizing these interactions by employing various biophysical tools. Additionally, he will use programming to conduct data analysis and draw important connections. This research is important because it could lead to more effective methods of drug delivery that treat diseases more precisely and with fewer side of effects.

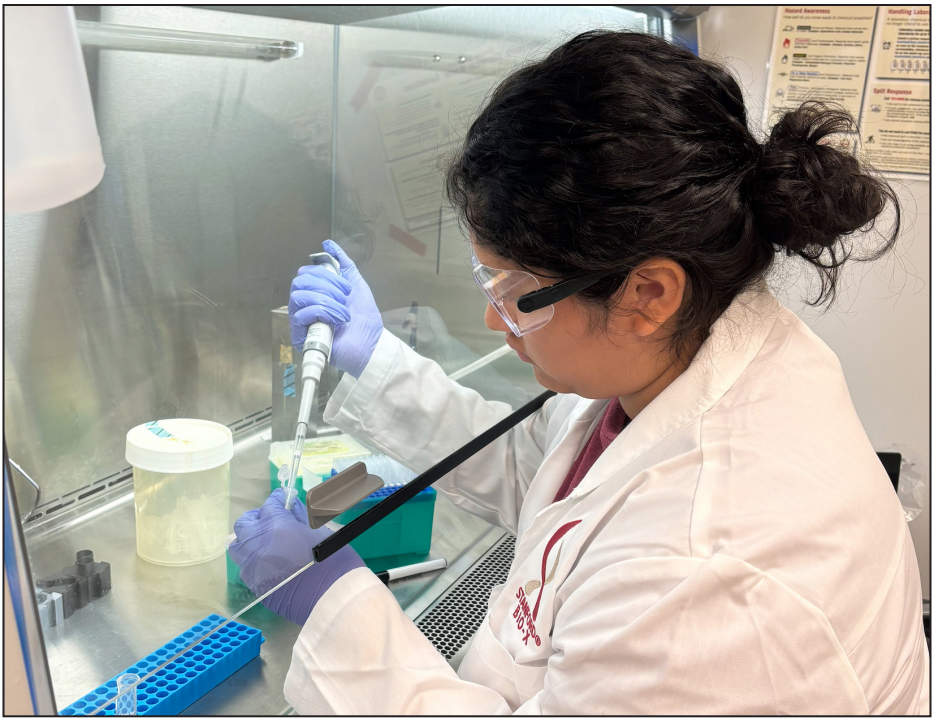
Sophia Artandi, Human Biology
Mentor: Michelle Monje (Neurology & Neurological Sciences)
Investigating Effect of Early Life Respiratory Infection and Secondary Immune Challenge on Long-Term Neurocognitive and Glial Dysregulation
COVID can cause lasting neurological symptoms, such as a "brain fog" syndrome of persistent cognitive dysfunction. The Monje lab is studying how respiratory immune challenges such as COVID and influenza can cause brain inflammation and consequent neural dysfunction – even when there is no brain infection, and how this "lung-brain" axis of inflammation may particularly influence children whose brains are still developing.



Cara Askren, Earth Systems
Mentor: Ayelet Voskoboynik (Biology)
Larvae on the Brink: Survival and Choice in a Changing Ocean
Cara's research project will examine the adaptability and survival of marine tunicate *Botryllus schlosseri* in varying conditions (e.g. temperature and pH levels), to explore how global warming might affect their populations. *B. schlosseri* is the closest invertebrate relative to humans and is an important model organism for the study of aging and stem cell regeneration. The Voskoboynik lab hopes to understand how changes to *B. schlosseri*'s environment and health could impact future medical research. Collecting wild mother colonies and letting larvae settle freely in varying conditions will allow Cara to observe their success rates over time through reproduction rates and longevity.



Alex Perry completed his Stanford Bio-X summer research training with Dr. Vivek Buch



Alison Fajardo completed her Stanford Bio-X summer research training with Dr. Guosong Hong

Sasha Balasingam, undeclared
Mentor: Joachim Hallmayer (Psychiatry & Behavioral Sciences)
Alpha-Waves and Autism Spectrum Disorder (ASD) – A Study of Humans and Zebrafish
Electroencephalographic (EEG) abnormalities including a reduced activity of medium frequencies (alpha) have been reported in individuals diagnosed with Autism Spectrum Disorder (ASD). These abnormalities impact an autistic person's ability to feel empathy and self-awareness, which are overall core deficits of autism. Recently, variants in three genes have been detected that affect the alpha rhythm. Sasha will leverage comparative biology across humans with ASD and complementary genetic zebrafish models to test whether the effects of these genes in zebrafish converge with the brain activity in ASD. She will engineer mutations in the genes in zebrafish and perform human EEGs and fish EEG-equivalent. The result will help us to understand core symptoms of ASD and why individuals with ASD process certain social deficits differently.

Samuel Benabou, Engineering
Mentor: Yanmin Yang (Neurology & Neurological Sciences)
Investigating the Role of a Receptor-Related Protein in Neuronal Tau Propagation
Tau protein aggregation is the most well-understood mechanism of neurodegenerative disease, a cognitive condition affecting 15% of the world's population. However, there is little evidence of the specific proteins that allow tau protein to initially propagate inside the neuron. Sam will be researching the expression of highly regulated genes and their function *in vitro* in response to tau protein variants. Further, he will use computational modeling techniques to understand how the tau proteins interact with the proteins on the neuronal membrane surfaces.

Corynn Branche, Biology
Mentor: Han Zhu (Medicine - Cardiovascular Medicine)
Identification of Peripheral Biomarkers for Immune Checkpoint Inhibitor Induced Cardiotoxicity in Patients with Elevated Troponin
Immune checkpoint inhibitors (ICIs), a new class of chemotherapy medication, have been associated with rare, but often fatal heart inflammation called myocarditis. Definitive diagnosis requires extensive imaging or myocardial biopsy, posing a significant financial and physical burden on patients. The team aims to investigate potential peripheral biomarkers for the less invasive diagnosis of ICI-myocarditis in patients with elevated troponin. The lab has previously identified immune cell subsets key to the development of myocarditis in mouse models. Using single cell RNA sequencing of human samples, Corynn will identify and interrogate peripheral immune populations associated with increased cardiac risk.

Brandon Bui, Human Biology
Mentor: Claudia Petritsch (Neurosurgery)
Modeling Tumor Development and Progression for Clinically Threatening Pediatric Glioma
Pediatric low-grade glioma is the most common childhood brain tumor and can progress into high-grade glioma marked by intra-tumoral heterogeneity, immunosuppression, and fast growth, which is lethal despite extensive treatment. The biological processes associated with the tumor microenvironment (TME) that support tumor progression are poorly understood, posing a roadblock in effective drug development. Using novel mouse models, Brandon will perform single-cell transcriptomic profiling and multiplex immunohistochemistry at different stages of progression to reveal the spatiotemporal interaction networks among glial, immune, and tumor cells in the TME. This project will guide development of targeted therapies aimed at preventing tumor progression.

Vibhu Guru completed her Stanford Bio-X summer research training with Dr. Lucy O'Brien

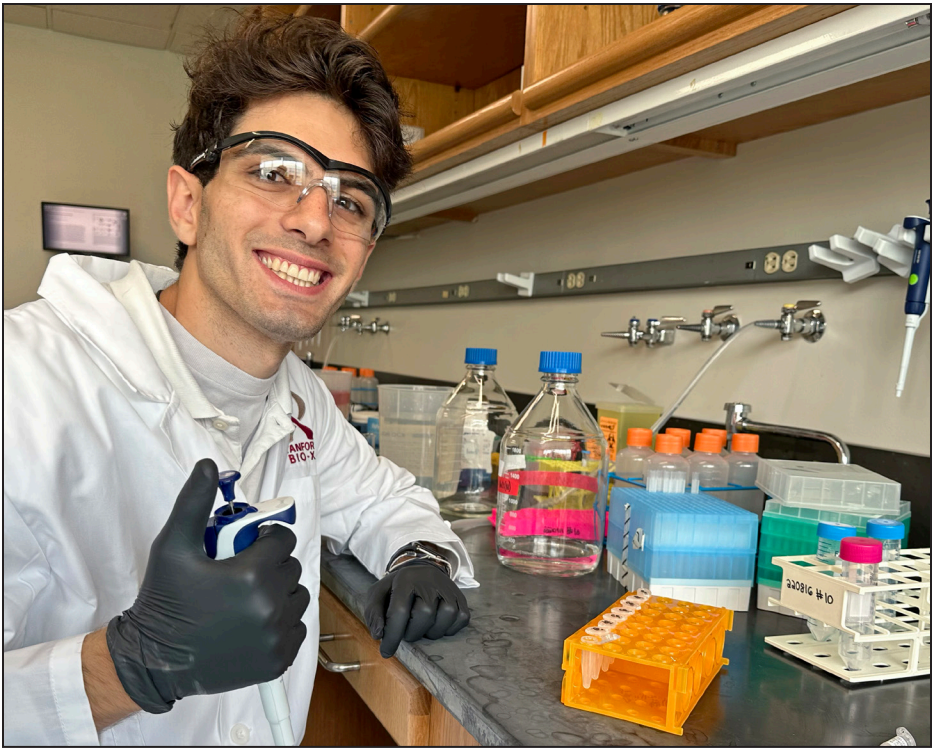
Ronny Junkins completed his Stanford Bio-X summer research training with Dr. Jill Helms

David Candes, Biology
Mentor: Ron Kopito (Biology)
Understanding the Role of UFM1 in Ribosome Recycling

The proper function of ribosomes is essential for maintaining a healthy proteome (the complete set of proteins expressed by an organism). Previously, the Kopito lab found that UFM1, a small protein similar to ubiquitin, is conjugated to UFMylation and is necessary for the recycling of ribosomes that stall at the endoplasmic reticulum (ER) during translation. The mechanism of ribosome release from the ER, a structurally complex and coordinated process which ultimately requires the removal of UFM1 (deUFMylation), leaves questions about whether the UFMylated ribosome undergoes a "quality check" as part of the recycling process. David will develop methods to transiently knockdown deUFMylation machinery, trapping the ribosome in the UFMylated, ER-bound state, to then better study the role of UFM1 in ribosome quality control.

Vibiana Cardenas, Biology
Mentor: Liqun Luo (Biology)
Elucidating the Functional Heterogeneity of the Serotonin System in Social Behaviors

Brain serotonin modulates wide-ranging behaviors including social interaction, and it is the top therapeutic target for treating neuropsychiatric disorders. However, due to its anatomical complexity, little is known about the system's functional organization, namely which serotonin subtypes affect which behaviors. Using optogenetic techniques, Vibiana will activate anatomically-distinct serotonin subpopulations in mice. She will (1) test the hypothesis that the activity of different serotonin subtypes affects social behaviors differently, and (2) isolate serotonin subpopulations that are sufficient to positively or negatively affect social engagement. Results from this project will elucidate the functional heterogeneity of serotonin in social behaviors, which may help develop better targeted pharmacological treatments for neuropsychiatric disorders.



Marc Arslanian completed his Stanford Bio-X summer research training with Dr. Naima Sharaf

Riley Carolan, Chemistry
Mentor: Claudia Padula (Psychiatry & Behavioral Sciences)
Efficient Implementation of Novel Methods for Measuring Scalp to Cortex Distance
Current treatments for alcohol use disorder (AUD) result in nearly 2/3 of patients relapsing within 6 months. Transcranial magnetic stimulation (TMS), a form of non-invasive brain stimulation, is an emerging treatment option for AUD. TMS efficacy is directly dependent on the distance between the brain and scalp. Importantly, AUD is associated with brain atrophy, which likely lengthens scalp-to-cortex distance and may reduce TMS efficacy. Riley's project will entail assisting in developing novel methods for measuring the scalp-to-cortex distance among AUD patients. This work will inform future TMS protocols and enable patient tailoring of stimulation strength.

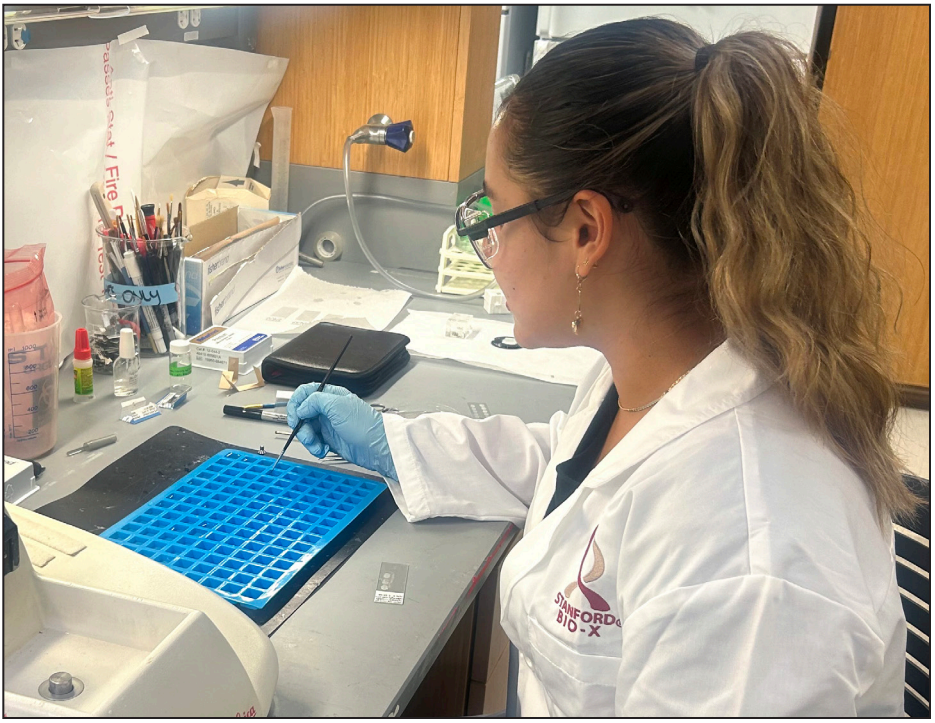
Maria Valentina Chirinos-Pena, Human Biology
Mentor: William Talbot (Developmental Biology)
CRISPR-Based Knock-In of Neuregulin 1 Type II Fluorescent Tags in Zebrafish to Study Myelination Pattern Diversity *in vivo*
The goal of Maria Valentina's research project is to visualize the signaling proteins that direct the formation of nerves in living embryos. Using the transparent zebrafish embryo, she plans to insert fluorescent tags into the neuronal signaling proteins that control the formation of the myelin sheath in nerves. This cutting-edge approach promises unprecedented insights into the mechanisms governing distinct patterns of myelin formation on different axons. Maria Valentina's work will address major questions in neuroscience and illuminate our understanding of nervous system development.

Vedant Chittake, Bioengineering and Chemistry
Mentor: Fan Yang (Orthopaedic Surgery and Bioengineering)
A Tissue-Engineered 3D Triculture Model Simulating Breast-Cancer Bone Metastasis for Drug Screening

Breast cancer-bone metastasis affects over 65% of advanced cases, leading to severe complications. This project aims to develop a spatially-patterned 3D triculture model mimicking human bone and breast cancer interaction to study metastasis-inhibiting drugs. Using various pre-clinically established targeted and endocrine drugs, Vedant will demonstrate the utility of the model in testing drug efficacy on immortalized cancer cell lines (MDA-MB-231, MCF-7), by studying the impact of these treatments on cancer cell proliferation, invasion, survival, and bone remodeling dysregulation. This model could serve as a useful platform to pinpoint new effective treatments for inhibiting metastasis, addressing gaps in current therapeutic strategies.

Puja Chopade, undeclared
Mentor: Brad Zuchero (Neurosurgery)
Building New AAV Tools for Studying the Role of Myelin in Neurodegenerative Disease

As the aging population grows, Alzheimer's Disease (AD) cases – currently ~6,700,000 in the US – are projected to increase dramatically. Recent research increasingly suggests that myelin dysfunction plays an important role in AD. However, progress in this field is restricted by limitations in genetic engineering using adeno-associated viruses. Puja's project tests several methods to optimize AAVs, including increasing their packaging capacity by shortening promoter sequences and replacing standard long poly-A tails with short poly-A tails found in myelin basic protein genes. Thus, researchers can study larger genes involved in myelin dysfunction, increasing possibilities for glial biology research and leading to new directions for Alzheimer's therapeutics.



Gwendolyne Aguilar completed her Stanford Bio-X summer research training with Dr. Jason Tucciarone

2016 Stanford Bio-X Undergraduate Summer Research Program Participants

Andrea Cortez, Bioengineering

Mentor: Rogelio Hernández-López (Bioengineering and Genetics)

Engineering T Cell Therapies for Heterogeneous HER2+ Breast Cancer

Breast cancer is the leading cause of cancer in women, affecting women of color disproportionately. This project focuses on engineering cell therapies for a subtype of breast cancer that presents heterogeneity of the antigen HER2. Specifically, Andrea and the team will engineer T-cells that discriminate normal tissue from cancer cells to create targeted therapies for tumors. They will use a variety of cell lines expressing different levels of HER2 and co-culture them with human primary CD8 and CD4 T-cells, while assessing the killing activity by microscopy and flow cytometry. Overall, they will create therapies that can discriminate the differences in HER2 density for better cancer therapies.

Binta Diallo, Human Biology

Mentor: Judith Shizuru (Medicine - Blood & Marrow Transplantation and Cellular Therapy Division)

Blood Stem Transplantation and the Bone Marrow Microenvironment

Bone marrow transplants are often the best treatment and the only potential cure for blood or immune disorders. However, traditionally, for bone marrow transplants to engraft successfully, patients have to be pre-treated with radiation and chemotherapy. The lab aims to leave these toxic pre-treatments in the past and venture into a future where antibodies can be used to clear a host's stem cells from their bodies, ensuring successful engraftment. Binta will do this by identifying the changes that immune T cells and specific, disease-induced inflammatory states impart on the bone marrow environment that lead to suppression of blood formation and resistance to stem cell engraftment.

Alison Fajardo, Chemical Engineering

Mentor: Guosong Hong (Materials Science & Engineering)

Bioprospecting and Directed Evolution of Nitrogen-Fixing Enzymes That Can Function in Eukaryotes

Ammonia fertilizer, which is necessary for agriculture and carbon sequestration, is produced by the fossil-fuel dependent Haber-Bosch process. Ammonia runoff pollutes our waterways, increases soil acidification, and kills aquatic life. Biological nitrogen fixation into ammonia is currently limited to bacterial cells. Alison's project will focus on creating enzymes for plants to produce ammonia. When put into industry use, this will lower the cost of agriculture. Her approach is to find and optimize functioning enzymes in yeast, which alone can mitigate many sources of CO_2 emissions (e.g. generating biofuels and biomaterials). Adding these into plants could revolutionize agriculture.

Gabrielle George, undeclared
Mentor: Joseph Woo (Cardiothoracic Surgery)
Monomeric SDF-1a Analog: Protein Engineering to Promote Angiogenesis Following Ischemic Injury
Gabrielle's project aims to engineer and assess a monomeric SDF-1a analog (MSA), a protein designed to promote angiogenesis for myocardial ischemia. By determining a design that does not experience degradation from enzymatic activity, the MSA is intended to stimulate regeneration of blood vessels following ischemic injury. Gabrielle's project will examine the structure of the MSA through size exclusion chromatography at the Stanford Linear Accelerator Center (SLAC) and then conduct a Boyden chamber assay to analyze *in vitro* chemotaxis with human endothelial cells. Eventually, the MSA will be injected into the myocardium of adult mice after a myocardial infarction to determine its angiogenic capabilities.

Milo Golding, undeclared
Mentor: Jill Helms (Surgery - Plastic & Reconstructive Surgery)
An Experimental Approach for Optimizing Conditions for Liver Preservation
Successful liver transplantation depends upon maintaining liver viability during retrieval and preservation. The Helms lab aims to study two critical variables: the effect of temperature and the effect of preservation solutions on liver viability. Milo will utilize a newly established *ex vivo* liver slice system to address the extent of caspase-mediated programmed cell death and wnt-dependent stem cell activation to quantify the effects of storage temperature e.g., 0-4°C, 5-8°C, and +23°C. The goal is to translate these findings into a novel strategy to limit ischemic damage in the liver, specifically in the time period between organ retrieval and transplant.

Leah McGillicuddy completed her Stanford Bio-X summer research training with Dr. Nidhi Bhutani

Cara Askren completed her Stanford Bio-X summer research training with Dr. Ayelet Voskoboynik

Maya Goldsberry, undeclared
Mentor: Eric Gross (Anesthesiology, Perioperative & Pain Medicine)
Novel Aldehyde Dehydrogenase 2 Variants in Africans/African Americans Affect Acetaldehyde Metabolism
Every wonder why some people flush after drinking alcohol? This summer, Maya will have the opportunity to try to understand how genetic variations in a specific enzyme known as aldehyde dehydrogenase 2 (ALDH2) may lead to alcohol flushing. This work will lead to a greater understanding of whether carrying certain inactive ALDH2 genetic variants can lead to a higher risk of heart disease and cancer when consuming alcohol.

Jesse Grayson, undeclared
Mentors: Danielle Mai (Chemical Engineering)
Protease-Activated Elastin-Like Polypeptides with GFP
Inducing a slower, more stable diffusion of medicine and targeted drug delivery, an issue in modern medicine administration today, could be enabled through enzymatically altering a soluble drug protein locally and changing it from soluble to solid. This is the motivation behind Jesse's summer project. Previous research has been conducted on proteases excising hydrophilic portions (soluble) of an elastin-like protein (ELP) and subsequently coagulating (turning solid). Jesse's project would expand upon this by investigating the phenomenon in the context of an ELP attached to a protein with more complex folded tertiary structure, GFP, rather than the simple unfolded ELP alone.

"Getting to work full-time in the lab was fulfilling... Usually I'm interrupted by my class schedule and find it difficult to carve out chunks of time big enough for my work. Planning and executing a long-term project... this summer has given me more confidence in my abilities and has solidified my interest in my research."
—2023 USRP Participant Autumn Parrott

Vibhu Guru, Computer Science

Mentor: Lucy O'Brien (Molecular & Cellular Physiology)

Live Imaging of Regenerative Tissue Dynamics in the *Drosophila* Gut

Tissue damage triggers a rapid, yet regulated, repair response, necessitating intricate coordination among responding neighboring cells. These dynamic cell-cell interactions are poorly understood due to challenges in imaging live responses. Vibhu's project will use Bellymount, a live imaging technique developed by the O'Brien lab, to examine cell-cell interactions during injury in the *Drosophila* intestinal tract. Vibhu will combine genetic manipulations and computational image analysis to dissect how cells interact during an injury response. This study will enhance our understanding of tissue repair mechanisms, leveraging the unique advantages of the fly gut model to shed light on cellular coordination during regeneration.

Jennifer Hamad, Biology

Mentor: Crystal Mackall (Pediatrics - Hematology & Oncology and Medicine - Blood & Marrow Transplantation)

Overcoming Fas Ligand-Fas Receptor Mediated T Cell Apoptosis in the Tumor Microenvironment

Overcoming the immunosuppression of the tumor microenviornment (TME) that sustains tumorigenesis remains a challenge in the development of successful cancer immunotherapies. One of the ways that solid tumors mount immunosuppression is through the Fas Ligand (FasL)-FasR Receptor (FasR) apoptotic pathway. By overexpressing FasL, tumors eliminate infiltrating lymphocytes that express FasR. To overcome this challenge, Jennifer will work on designing CAR T cells with cleavable Fas receptor that can penetrate the TME without falling victim to FasL-FasR mediated T cell death, at least immediately. The ultimate goal is to develop a CAR T cell therapy that can treat solid tumors.

Bradley Moon completed his Stanford Bio-X summer research training with Dr. James Chen

Katherine Healzer, Biology
Mentor: Jeffrey L. Goldberg (Ophthalmology)
Novel Biomarkers in Glaucoma for Neuroprotection and Vision Restoration

Glaucoma is the leading cause of irreversible blindness and affects more than 80 million people worldwide. The goal of Katherine's research is to study retinal structure-function correlation to discover biomarkers which will improve early diagnosis, prognosis, and evaluation of therapeutic response in glaucoma patients. She will analyze structural changes of axon atrophy and retinal nerve fiber layer thickness using visible-light optical coherence tomography (vis-OCT) and correlate this to the functional analysis with visual field defects and visually evoked potential electroencephalograms. Her passion to turn "irreversible" to "reversible" vision loss motivates her pursuit and dedication to glaucoma research.

Elizabeth Hong, undeclared
Mentor: Catherine Blish (Medicine - Infectious Diseases)
Investigating the Effects of Vaccine Adjuvants on NK Cell Function for the Improvement of Vaccination Strategies

Natural killer cells (NKC) play a vital role in regulating vaccine response and antibody specificity. While classically recognized as innate lymphocytes that kill infected cells, high NKC activity is associated with poor antibody/vaccine responses. *In vivo*, NKC depletion in mice leads to higher antibody levels. However, the impact of vaccine adjuvants on NKC activity is not known. Using tonsil/spleen organoid vaccine response models with human cells, Elizabeth aims to evaluate different vaccine adjuvants on NKC activity. Outcome measures include NKC phenotype, organoid cell proportions, and antibody response. The lab hypothesizes that adjuvants that activate NKC will adversely impact vaccination response.

Selena Niemi (pictured at far right, with Howard Fung, left, and Dr. Cassie Eng, center) completed her Stanford Bio-X summer research training with Dr. Allan Reiss

Nicholas Neoman completed his Stanford Bio-X summer research training with Dr. Kathleen Sakamoto

Ethan Htun, undeclared
Mentor: Craig Levin (Radiology)
Enhancing PET Image Reconstruction via Deep Learning Models
Positron emission tomography (PET) is an imaging technique that is used to study cancer, heart disease, and neurological disorders. Two commonly used image reconstruction algorithms are used to visualize PET data: OSEM (faster but makes fuzzier images) and BSREM (slower but generates more accurate images). Ethan's research project aims to develop a deep learning (DL) model to improve OSEM-reconstructed images to a quality comparable to that of BSREM-reconstructed PET images. If successful, this approach allows faster reconstruction of high-quality PET images.

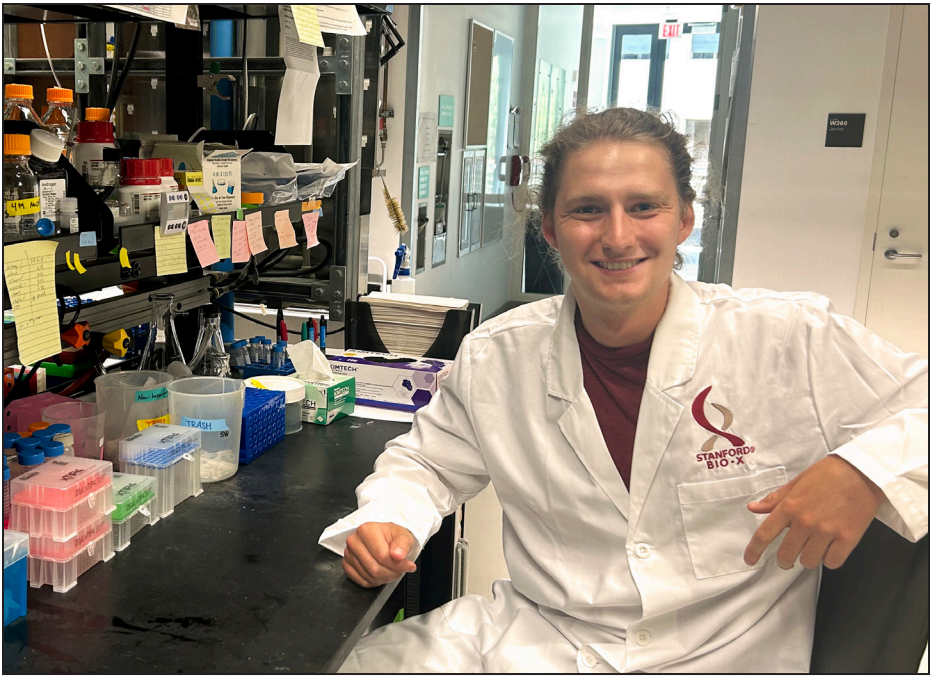
Eu Jin Jung, Biology
Mentor: Michelle Monje (Neurology & Neurological Sciences)
Targeting Voltage-Sensitive Mechanisms of Glioma Growth
High-grade gliomas are aggressive brain tumors whose progression is regulated by neuronal activity and the brain microenvironment. Professor Michelle Monje's laboratory discovered that glioma membrane depolarization promotes glioma growth through unknown voltage-regulated signaling mechanisms. Results from a CRISPR/Cas9-based genetic screening suggest that voltage-gated calcium channels may be crucial in converting electrical activity to promote glioma growth. Eu Jin will validate the candidate calcium channels using genetic deletion or pharmacological inhibition in neuron-glioma co-culture. This project is in the intersection between neuroscience and cancer biology and may identify novel therapeutic targets for glioma.

Ronny Junkins, Mathematics
Mentor: Jill Helms (Surgery - Plastic & Reconstructive Surgery)
Machine Learning Algorithm to Predict Function of Transplanted Liver
For patients with end-stage liver disease, liver transplantation is the only effective treatment. However, approximately 30% of patients die while waiting for a liver transplant. Compounding the scarcity of donor livers, up to 70% of such livers are discarded due to concerns of poor quality and organ failure following transplantation. By combining artificial intelligence technology with the Scientific Registry of Transplant Recipient data set, which provides recipient and donor characteristics together with transplant outcomes from 1988 to present, Ronny will develop an organ selection algorithm to optimize liver utilization and improve liver transplantation rates without compromising transplant outcomes.

Ryan Kern, undeclared
Mentor: Joseph Wu (Medicine - Cardiovascular Medicine and Radiology)
Cardiac Amyloidosis Disease Modeling using iPSC-derived Cardiomyocytes and 3D Cardiac Organoids
Transthyretin Cardiac Amyloidosis (ATTR-CM) is characterized by the misfolding of TTR proteins, resulting in the formation of fibrils in the heart and subsequent heart failure. This condition affects a significant portion of the elderly population, with TTR deposits present in 25% of individuals aged 80 and above. Currently, there is a lack of an accurate cell culture model to study disease progression. Ryan's project aims to optimize cell culture conditions by generating induced pluripotent stem cell (iPSC)-derived cardiomyocytes and 3D-organoids to better replicate disease conditions. This improved model will facilitate the development of more effective therapeutics for treating ATTR-CM.

Taeil Matthew Kim, Biology
Mentor: Joseph Shrager (Cardiothoracic Surgery)
***Ex Vivo* Lung Perfusion (EVLP) and *Ex Vivo* Heart Perfusion (EVHP) System for Rats**
An *Ex Vivo* Lung Perfusion (EVLP)/*Ex Vivo* Heart Perfusion (EVHP) System for Rats is necessary to establish them as a viable model for transplantation research. Over the summer, Taeil Matthew will design and improve these systems while performing rat surgeries. This will allow evaluation of organ function and testing of experimental recovery and treatments before application to larger animals or clinical settings. Currently, the standard with animal studies on EVLP/EVHP has been large animals, such as pigs. However, small animal models like rats would offer more timely, less costly, and less labor intensive studies, greatly accelerating our research on organ transplantation.

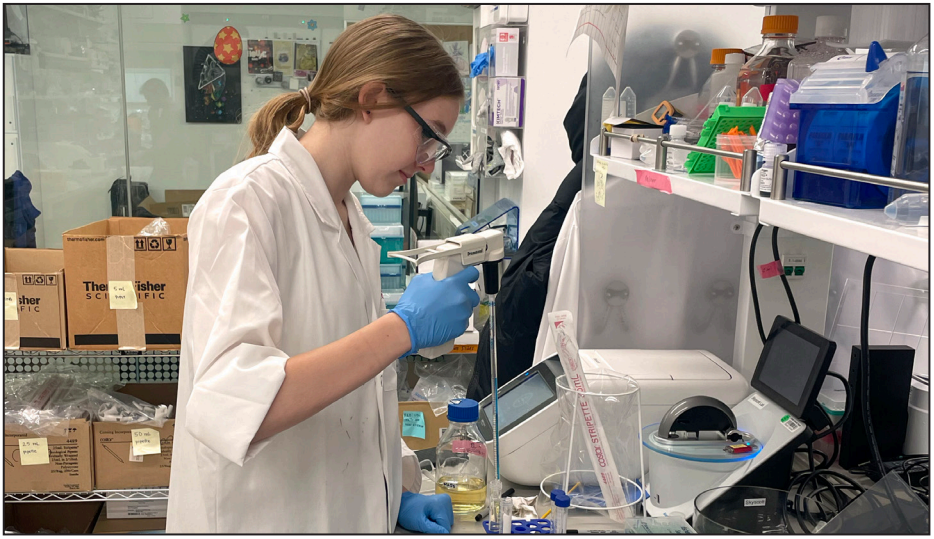
2017 Stanford Bio-X Undergraduate Summer Research Program Participants



Sybren van den Bedem completed his Stanford Bio-X summer research training with Dr. Soichi Wakatsuki

Abigail Lee, undeclared
Mentor: Lauren Goins (Developmental Biology)
Identifying Proteins That Regulate Asymmetric Cell Division During Hematopoiesis
A fundamental mechanism by which hematopoietic stem and progenitor cells balance self-renewal with differentiation is via asymmetric cell division (ACD). When this becomes unbalanced, profound blood disorders arise, disrupting normal blood cell distribution and multilineage blood cell development. Abigail's project will be focusing on screening through candidate ACD proteins with RNAi and immunofluorescence, and monitoring differences in hematopoietic cell types. Abigail will work on understanding the roles of ACD proteins Mira, Lgl, and aPKC in cell fate determination in the hematopoietic progenitor population, specifically using *Drosophila* to aid in the development of a testable system to study ACD in hematopoiesis.

Aubrey Lemer, Chemistry
Mentor: Thomas Südhof (Molecular & Cellular Physiology and Neurosurgery)
Understanding the Roles of ApoE2 and ApoE4 in Alzheimer's Disease Pathology
Aubrey's project aims to investigate the role of human apolipoprotein E (ApoE) isoforms, particularly ApoE2 and ApoE4, in Alzheimer's disease pathology, focusing on their interaction with amyloid-β (Aβ) in the brain. This will be achieved through robust experimental approaches, including the differentiation of human embryonic stem cells into neurons and co-culturing with ApoE-producing glial cells. Key experiments will monitor Aβ levels, evaluate the impact of pharmacologically eliminating Aβ, and assess synapse number and activity. These methodologies will provide comprehensive insights into the ApoE-Aβ interaction, potentially unveiling new therapeutic targets for Alzheimer's disease.



Elsa McElhinney completed her Stanford Bio-X summer research training with Dr. Mark Skylar-Scott

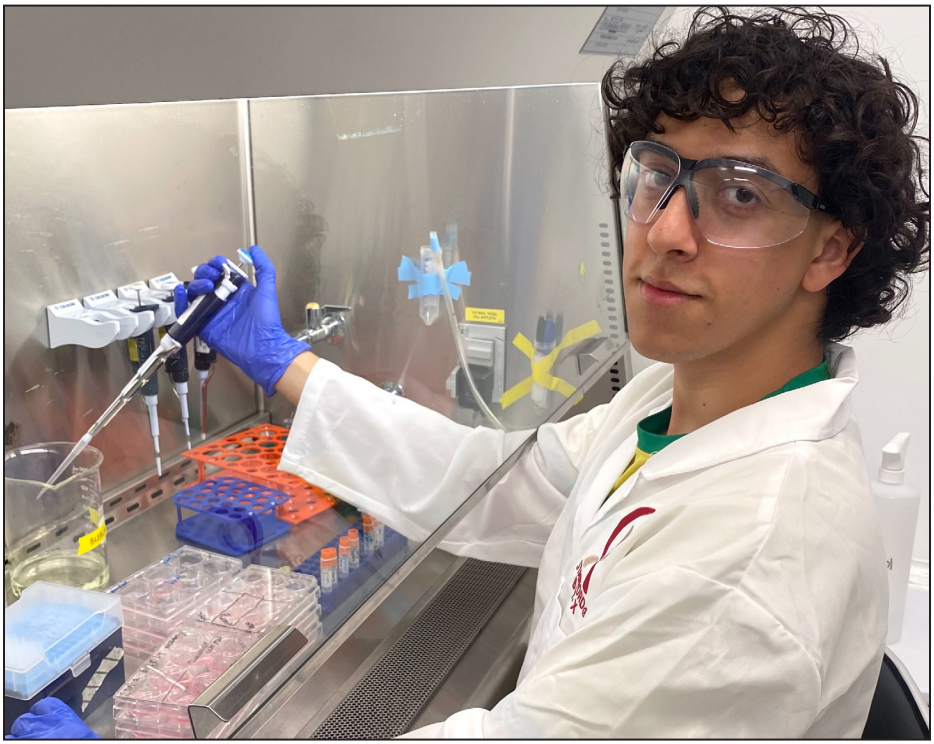
Brian Lim, Bioengineering
Mentor: Justin Annes (Medicine - Endocrinology)
Optimization of Beta-Cell-Selective Accumulation and Bio-Activity of Zinc-Dependent Beta-Vell-Targeted Compounds
Development of improved diabetes medications is stymied by a dearth of safe therapeutic targets. On-target but off-tissue drug effects are slowing progress across multiple therapeutic domains, including β-cell regeneration, β-cell preservation, and immune-protection. In principle, therapeutically stimulating β-cell regeneration could be used to restore endogenous insulin production capacity, but non-selective replication-promoting activity is preventing clinical development. To address this challenge, Brian will help develop a β-cell-targeted drug delivery module based upon the uniquely high zinc content of β-cells. Brian will test structurally diverse zinc-dependent β-cell-targeted compounds to optimize β-cell-selective accumulation (LC-MS/MS) and bio-activity (target (DYRK1A) inhibition and β-cell replication).

Ellie Lin, undeclared
Mentor: Laura Prolo (Neurosurgery)
Studying the Role of Molecular Drivers of Pediatric Glioma Tumor Cell Invasion Using CRISPR-Screening Approaches
Pediatric brain tumors are the leading cause of cancer-related deaths in children, however the molecular drivers of tumor cell invasion are still not well characterized. Using a genome-wide CRISPR screen, the Prolo lab identified MAP4K4 as a key regulator of tumor cell invasion in high grade gliomas. Ellie will investigate how downstream effectors of MAP4K4 (ie. LATS1/2, YAP/TAZ) affect tumor cell invasion dynamics when cells use cytoplasmic structures called tumor microtubes to move, both *in vitro* and *ex vivo*. By identifying the genes responsible for the invasive nature of pediatric glioma cells, the lab will be closer to preventing recurrence.

"I had never participated in a journal club before, so just getting familiar with presenting and reading scientific literature has been really valuable. I enjoyed meeting other people from such a wide range of disciplines... there are so many areas of study that different students are interested in."
—2023 USRP Participant Eli Wandless

Vladimir Mamchik, undeclared
Mentor: Daniel Palanker (Ophthalmology)
Optimization Of The 3-Dimensional Implants for Highest Prosthetic Acuity in Human Retinal Geometry
Retinal degenerative diseases are the leading cause of untreatable visual impairment associated with the loss of photoreceptors. Since, in these conditions, the inner retinal neural network remains largely intact, electronic photoreceptors, in the form of a photovoltaic subretinal implant, have been developed to reintroduce visual information by electrical stimulation of the inner retinal neurons. Vladmir's project will involve the design of structures mimicking the subretinal tissue around the implant and fabrication of the implants using rapid prototyping tool Nanoscribe. He will also evaluate spatial resolution with retinal implants *in vivo* in rats using electrophysiology and tissue assessment by immunohistochemistry.

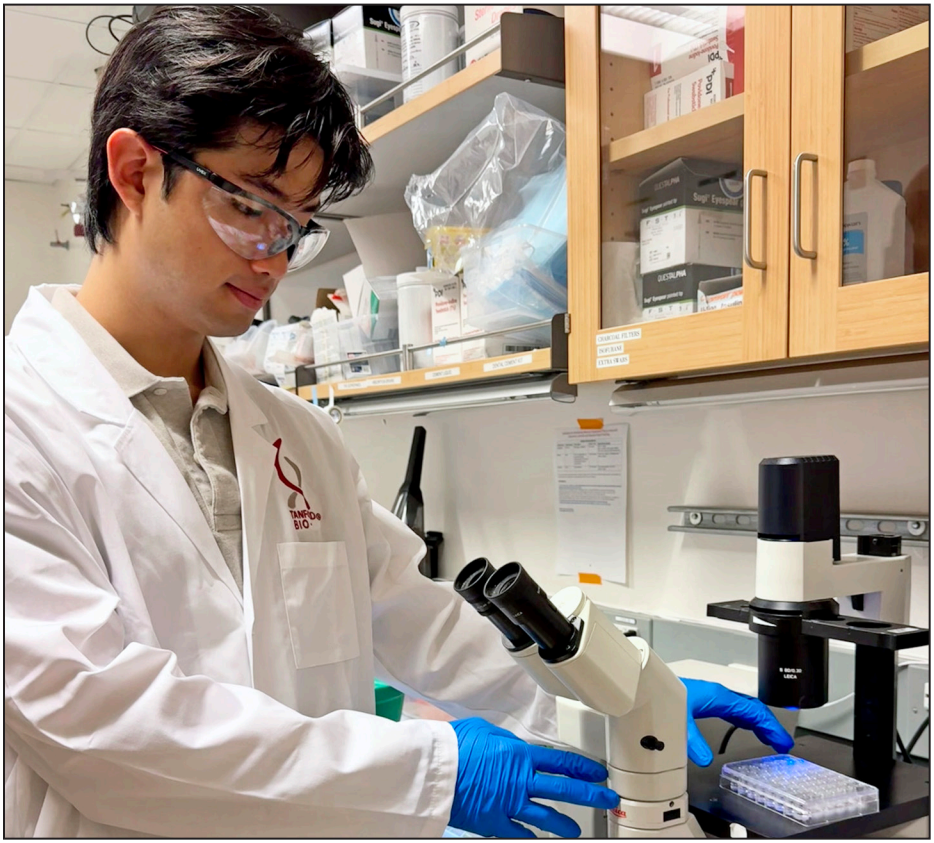
Kate Mattox, Biology
Mentor: Boris Heifets (Anesthesiology, Perioperative & Pain Medicine)
Immunohistological Characterization of the Neuronal Serotonin 5-HT2A Receptor in a Novel Transgenic Mouse Model
Psychedelic drugs show promise for treating depression, PTSD, and anxiety; however, our neurobiological understanding of their action is incomplete. A key barrier to progress has been an inability to visualize which neurons express the key psychedelic receptor, the 5-HT2A receptor. Using a mouse model that has fluorescent 5-HT2A receptor-positive neurons, Kate will be trained to characterize 5-HT2A receptor expression in the whole mouse brain, acquiring experience in rodent handling, microdissection, vibratome sectioning of brain tissue, immunohistochemistry and fluorescence microscopy techniques. This work is important for serotonin neurobiology and may lead to the design of safer, more efficacious psychiatric medicines.



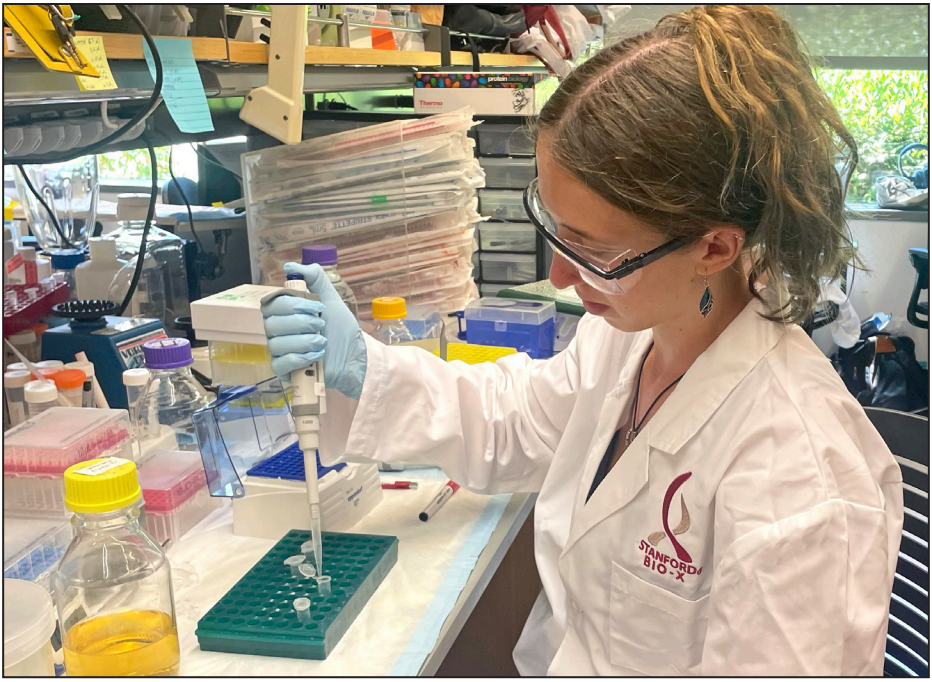
Ernesto Orellana completed his Stanford Bio-X summer research training with Dr. Maria Barna

Elsa McElhinney, undeclared
Mentor: Mark Skylar-Scott (Bioengineering)
Design and Testing of a Variable Diameter 3D Printer Nozzle
3D printing involves a key trade-off between print resolution and print speed: printing a part with twice the resolution increases print time approximately eight-fold. 3D printing using light is especially well-suited to creating high resolution tissues rapidly, but it is critically limited in material biocompatibility. This summer, Elsa will develop a new light-sensitive enzyme that rapidly generates high-resolution natural and biocompatible fibrin biomaterials upon exposure to a projected pattern of light. This would unlock the ability to print highly functional and high resolution tissues at scale.

Leah McGillicuddy, Bioengineering
Mentor: Nidhi Bhutani (Orthopaedic Surgery)
Elucidating Cell Fate Modulation through Precise Scaffold-Mediated Biophysical Stimuli
Leah will work on elucidating general biophysical stimuli that affect cell fate and function using a precise scaffold developed in the lab. This research is crucial for advancing tissue engineering, regenerative medicine, and therapeutic strategies by manipulating cell fate and function in a controlled manner. Besides regular meetings and supervision from her mentor Dr. Gupta, she will learn from the weekly lab meetings and journal clubs as well as direct meetings with Dr. Bhutani. Providing Leah with a direct research experience will allow her to learn scientific methodology, techniques, data analyses and hypothesis generation and testing capabilities.



Eu Jin Jung completed his Stanford Bio-X summer research training with Dr. Michelle Monje



Aubrey Lemer completed her Stanford Bio-X summer research training with Dr. Thomas Südhof

Shayaan Memon, undeclared
Mentor: Avnesh Thakor (Radiology)
Enhancing Therapeutic Efficacy in Pediatric Inflammatory Bowel Disease

In children, inflammatory bowel disease (IBD) poses a significant health challenge, necessitating targeted therapies. Shayaan's project proposes using mesenchymal stem/stromal cells (MSCs) derived from the umbilical cord, specifically primed with pulsed-focused ultrasound, to address the immune dysregulation and bioenergetic deficits in pediatric IBD. The study aims to optimize the priming process, evaluate therapeutic efficacy *in vitro*, and compare the outcomes of conventional intravenous administration with a novel intra-arterial approach in juvenile rats with colitis. The goal is to enhance treatment precision, reduce inflammation, and promote tissue regeneration, offering a promising avenue for urgently needed therapies in pediatric IBD.

Alexandra Midler, undeclared
Mentor: Michelle Monje (Neurology & Neurological Sciences)
Investigating the Role of Myelin Plasticity in Serotonergic Functions

Serotonergic circuitry modulates behaviors and contributes to psychiatric disorders, yet the mechanisms of neuroplasticity facilitating these diverse roles are incompletely understood. Alexandra's project explores whether oligodendrogenesis and myelination are necessary for serotonin-regulated behaviors. She will block oligodendrogenesis using the Cre-Lox system to conditionally knockout Myrf or TrkB in mouse oligodendrocyte precursor cells. She will then assess knockout and wild-type cohort performance on behavioral paradigms that robustly recruit serotonergic activity, and perform histological analysis to quantify oligodendroglia and myelination. This research will extend the connection between neuromodulatory systems and myelin plasticity, as well as contribute to our understanding of psychiatric pathologies.

Andrea Cortez completed her Stanford Bio-X summer research training with Dr. Rogelio Hernández-López

Bradley Moon, Mathematics

Mentor: James Chen (Chemical & Systems Biology, Developmental Biology, and Chemistry)

Elucidation of Substrates Essential for Homeodomain Interacting Protein Kinase 4 Function

The Chen lab established homeodomain-interacting protein kinase 4 (HIPK4) as essential for murine spermiogenesis. The mechanism by which loss of HIPK4 leads to male sterility is unknown; the lab hypothesized that HIPK4 coordinates sperm head formation by chaperoning filamentous actin proteins. Bradley's summer project will seek to characterize the mechanism by which these cofactors of HIPK4 contribute to this phenotype. Knowledge of this process will help develop specific small molecule inhibitors that target male contraception. Contraceptive efforts for men have been limited to hormonal or barrier-type devices, and a small molecule would serve to advance reproductive responsibility and autonomy.

Iliana Nava, Human Biology

Mentor: Margaret Fuller (Developmental Biology)

Exploring Changes in Protein Expression Due to Alternative 3' End Cleavage in Adult Stem Cell Lineage

In the *Drosophila* male germline, changes in gene expression drive the differentiation of spermatogonial cells to spermatocyte cells. During this differentiation, alternative 3' end cleavage produces mRNA isoforms that can lead to differences in protein expression and localization. Of the genes that shift the 3' UTR cleavage site, the majority shift from long 3' UTR in spermatogonia to short 3' UTR in spermatocytes. Manipulation of components PCF11 and CBC in the cleavage machinery produces a long 3' UTR in spermatocytes. Using immunofluorescence, Iliana will assay how the expression and localization of proteins are affected in PCF11 and CBC KD *Drosophila* germlines.

"I really loved the community that the program built within the cohort. I am excited to work with my peers in future courses and extracurriculars!"

—2023 USRP Participant and 2024 Cohort Lead Vivian Tien

Nico Neoman, African & African American Studies and Chemistry
Mentor: Kathleen M. Sakamoto (Pediatrics)
Characterization of the Molecular and Hematopoietic Phenotype of a Novel Mouse Model of Diamond Blackfan Anemia
Nico's research project focuses on the study of Diamond Blackfan Anemia (DBA), a disease that limits the amount of oxygen babies have access to. One gene of interest is Rpl11, a novel gene that, when mutated, shows a strong correlation with the development of DBA. Nico will research a deeper understanding of how this gene mechanistically causes DBA, directly through mouse modeling of the gene and studying DNA and blood samples through specific assays. He hopes to demonstrate more quantitative results of how this mutated gene creates DBA, which will offer insight into possible treatment solutions.

Jenny Nguyen, Bioengineering
Mentor: Scott Owen (Neurosurgery)
Characterizing the Physiological Mechanisms of Deep Brain Stimulation in a Mouse Model of Parkinson's Disease
Parkinson's disease is a neurodegenerative disorder that causes difficulties with motor and cognitive symptoms that severely impairs quality of life. Deep brain stimulation is a remarkably effective treatment for the symptoms of Parkinson's; however, the underlying mechanisms are poorly understood. Jenny's project seeks to characterize the physiological mechanisms of DBS in a mouse model of Parkinson's by (1) building and troubleshooting experimental tools for DBS and operant mouse behavior, (2) performing stereotaxic surgery to generate parkinsonian mice, and (3) collecting and analyzing behaviorial data through machine learning. These mechanistic insights will be important for advancing existing treatments in the clinic.

Noah Lowe completed his Stanford Bio-X summer research training with Dr. Keren Haroush

2012 Stanford Bio-X Undergraduate Summer Research Program Participants

Selena Niemi, undeclared
Mentor: Allan Reiss (Psychiatry & Behavioral Sciences and Radiology)
Clinical Application of Exercise-Based Virtual Reality on Cognitive and Brain Function for Neurodiverse Students with ADHD
With growth in virtual reality (VR) and digital health products targeting college students with attention deficit/hyperactivity disorder (ADHD) amid rising reports of physical inactivity and mental fatigue, there is a need for research on optimal practices to promote cognitive and physical activity in medicine. College students with ADHD face heightened cognitive demands during a transitional phase of increased autonomy. Selena will examine the effects of active VR interventions on brain function in adolescents with ADHD using advanced portable neuroimaging methods. This study will inform practical approaches for enhancing cognitive skills and supporting neural substrates in adolescents with ADHD.

Jessie Ong, undeclared
Mentor: H. Craig Heller (Biology)
Enhancing Sleep After Training Improves Memory in Down Syndrome Model Mice
Down Syndrome (DS) is associated with cognitive disabilities, for which there are no drug therapies. Moreover, adequate sleep is necessary to maintain optimal cognitive functions, and more than 60% of children with DS are reported to have sleep apnea. Using a DS model mouse, Jessie will investigate the potential beneficial effect of enhancing sleep on spatial and recognition memory. Jessie's research will enhance sleep with a behavioral (sleep deprivation resulting in sleep rebound) and pharmacological (hypocretin receptor 2 antagonist injection) approach to identify potential new therapies that improve sleep and abilities to learn and remember for individuals with DS.

"My favorite part [of the program] was the faculty lecture series. As I prepare to apply to grad schools this cycle, seeing different fields and types of work has helped me better understand what areas of science I enjoy. It is also very encouraging to see a diverse set of faculty being very successful."
—2022 USRP Participant and 2023 Cohort Lead Gabriela Rincón

Ernesto Orellana, Biology

Mentor: Maria Barna (Genetics)

Investigating Mechanisms of Cancer Resistance in *Ambystoma mexicanum*

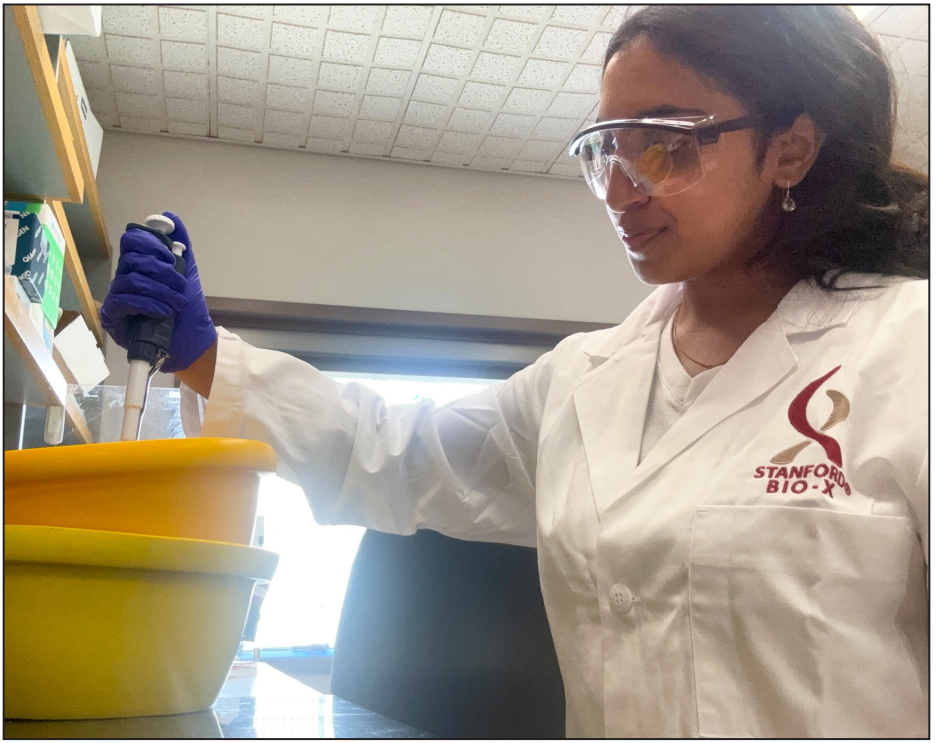
Axolotls are remarkable amphibians known for their exceptional ability to regenerate lost limbs, organs, and even parts of their brain throughout their lives, making them a subject of extensive scientific interest in the field of regeneration biology. In addition to their remarkable regenerative capacity, axolotls demonstrate a low incidence of tumor formation. Ernesto will investigate the role tumor suppressors have in cancer phenotypes by using CRISPR/Cas9 technology to inactivate the p53 gene in axolotl cells. p53 is the most commonly mutated tumor suppressor gene in cancer cells. This research strives to illuminate why axolotls are less likely to develop cancer compared to other species, such as mice.

Om Patel, Biology

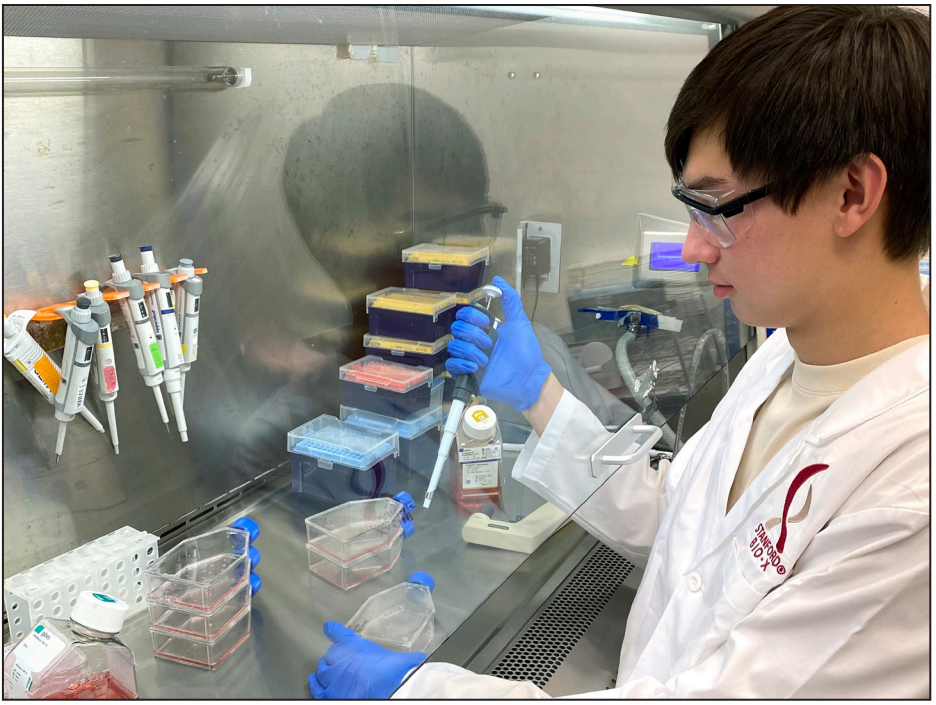
Mentor: Paul Cheng (Medicine - Cardiovascular Medicine)

Investigating the Impact of Tobacco Exposure on Smooth Muscle Cell Fate and Aneurysm Formation in Abdominal Aortic Aneurysm (AAA) Pathogenesis

50% of patients with ruptured abdominal aortic aneurysm (AAA) die before reaching the hospital. 90% of AAA patients have a history of tobacco use. The cellular and molecular mechanisms for how smoking induces aneurysms is poorly understood. Om will work on a combination of *in vitro* and *in vivo* models to answer this question. He will investigate how tobacco alters smooth muscle cell (SMC) transcriptome and behavior using single-cell RNA profiling alongside histological analysis using ongoing mouse models in the lab. In parallel, Om will perform experiments on primary human aortic SMC *in vitro* for additional mechanistic insight.



Sasha Balasingam completed her Stanford Bio-X summer research training with Dr. Joachim Hallmayer



Ryan Kern completed his Stanford Bio-X summer research training with Dr. Joseph Wu

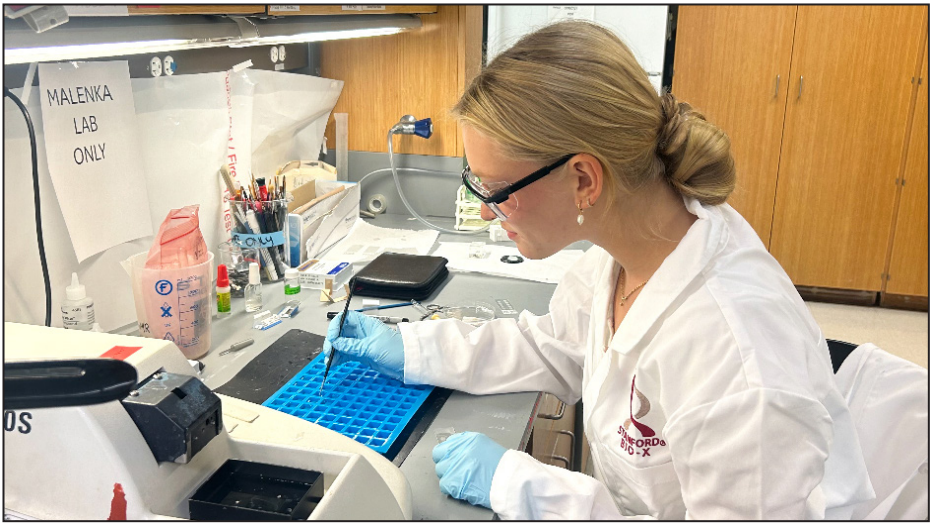
Alex Perry, undeclared
Mentor: Vivek Buch (Neurosurgery)
Using Intracranial EEGs to Understand Cognitive Health in Complex Neurodevelopmental Disorders Including Autism
Autism Spectrum Disorder (ASD) is one of the most common neurodevelopmental disorders, affecting 1 in 36 children in the US. Sleep abnormalities in ASD are well-known and thought to have significant impact on their cognitive processing dysfunction. ASD and epilepsy commonly co-occur, and as a pediatric epilepsy surgeon, Dr. Buch routinely records electrical activity inside brain tissue in children with ASD. Alex will analyze unique and rare electrical activity from important brain regions in ASD children during sleep, and correlate these patterns with cognitive health. The team hypothesizes that electrical imbalance in prefrontal circuits during sleep will predict performance on simple cognitive tasks.

Shriya Reddy, Engineering
Mentor: Euan Ashley (Medicine - Cardiovascular Medicine, Genetics, and Biomedical Data Science)
Detecting Hypertrophic Cardiomyopathy Through Whole Genome Sequencing and Deep Phenotyping
Shriya will be creating a model to predict the risk of hypertrophic cardiomyopathy (HCM) using deep learning tools on genomic, phenotypic, and imaging data available in the UK Biobank. She will develop and validate transformer models, which emphasize where a physician's attention is drawn to in medical images, to extract dozens of cardiac measurements that are clinically relevant for predicting HCM. These parameters will be combined with whole genome sequence data to produce an HCM risk score for each patient. Her research will contribute to more precise genetic risk prediction for HCM and lay the groundwork to better treat HCM patients with gene editing modalities.

Lauren Reyes, Human Biology
Mentor: Kristy Red-Horse (Biology)
Cxcr4 Signaling Increases in Response to Cardiac Injury
Coronary artery disease (CAD) is the leading cause of death in the world, and new treatments for this disease are needed. A promising potential treatment is inducing collateral artery formation between coronary arteries, since collaterals serve as a natural bypass of the heart. Previous research has revealed that neonatal mice form collaterals in a Cxcl12/Cxcr4 signaling dependent manner. To understand the mechanism further, Lauren aims to characterize Cxcr4 activation in injured mouse hearts. After injury, Lauren will fix, section, immunostain, and image the hearts. With the images, she will analyze zones of increasing distance from the injury.

Tooba Riaz, Biology
Mentor: Paul Bollyky (Medicine - Infectious Diseases and Microbiology & Immunology)
The Development of Ocean-Friendly Sunscreens Incorporating Bacteriophages
The world needs safe, biodegradable alternatives to conventional sunscreens. Traditional sun protection uses ingredients that raise both environmental and health concerns. Tooba will investigate the use of bacteriophages (viruses produced by bacteria) as a natural alternative for UV protection. Her goal is to develop an environmentally-friendly and effective solution for UV protection.

Irenka Saffarian-Deemyad, Physics
Mentor: Zev Bryant (Bioengineering)
Dynamics and Mechanics of Minimal RNA-Guided Nucleases
In December 2023, the FDA approved the first CRISPR/Cas9 gene therapy to treat sickle cell anemia, a disease affecting millions. Despite the transformative impact of CRISPR gene editing, applications remain limited by ease of delivery and efficiency of widely-used CRISPR endonucleases such as Cas9 and Cas12a. Irenka will use high-resolution biophysical measurements to investigate the mechanisms of small RNA-guided nucleases that are relatives and likely evolutionary ancestors of Cas12. Comparisons with Cas9 and Cas12a will illuminate the evolution and fundamental mechanisms of RNA-guided nucleases and may guide further development of minimal ancestral enzymes as compact gene editing tools.



Kate Mattox completed her Stanford Bio-X summer research training with Dr. Boris Heifets

2018 Stanford Bio-X Undergraduate Summer Research Program Participants

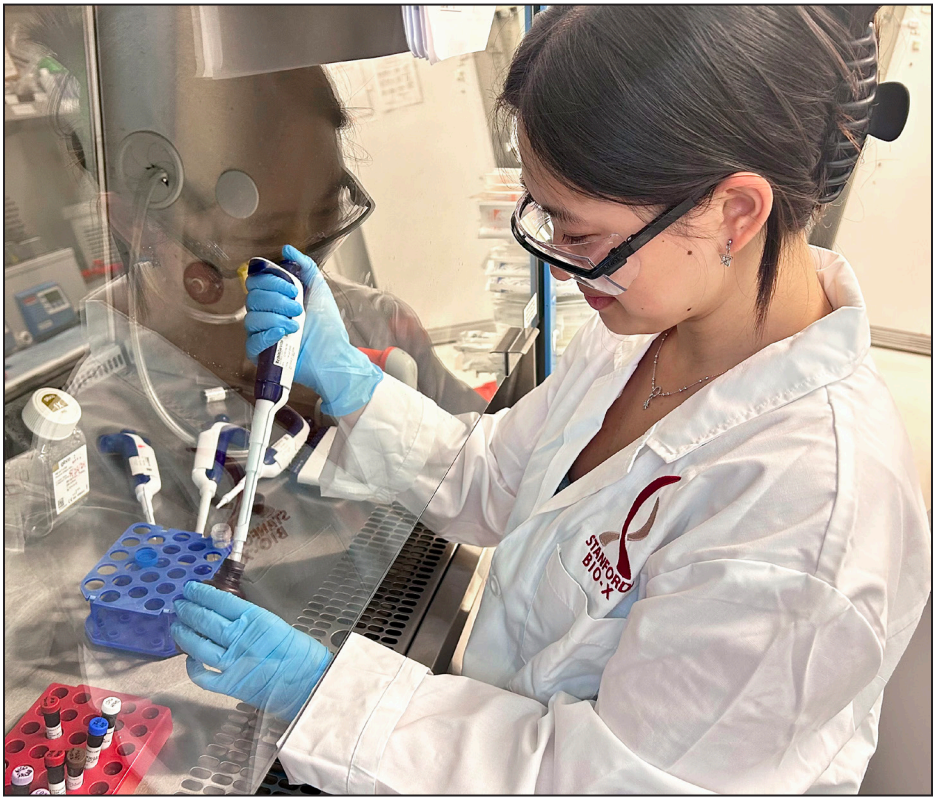
Arshia Sazi, undeclared
Mentor: James Dunn (Surgery - Pediatric Surgery)
Discovering Neurodegenerative Effects of Mechanical Force on the Second Brain: Insights from Hirchsprung Disease
Hirschsprung disease (HSCR) is characterized by aganglionic segments in the colon's terminus, impeding stool movement. In the dilated colon proximal to this segment, stool accumulation exerts pressure on the intestinal wall. The Dunn lab developed a murine model to investigate this intestinal mechanical dilation and its impact on enteric neuronal regeneration. Arshia's research focuses on the transcriptomics of neural circuits in colon sections experiencing this force in HSCR patients. He aims to identify neurodegenerative mechanosensitive elements through computational analysis of human datasets and *in vivo* data. His findings aim to reverse engineer a technique for neural regeneration in the enteric nervous system.

Max Scherer, undeclared
Mentor: Mark Skylar-Scott (Bioengineering)
Synthesis of De-Photopolymerizable Carbomer-Based Scaffolds for Embedded Bioprinting of Cardiac Tissue
The scaffold is a crucial component of the bioprinting process. Currently, crosslinkable carbomer-based scaffolds are unable to provide high-visibility environments for printed constructs without a second expensive polymer to photo-crosslink the carbomers. Max's research project focuses on chemical synthesis of photopolymerizable carbomer-based scaffolds for embedded bioprinting of cardiac tissues. Specifically, he will perform chemical modifications on carbomers to generate a widely-applicable photo-polymerizable scaffold material that would allow for easy tissue printing and high visibility using a light-based approach. Ultimately, the lab hope a single polymer, photocurable, transparent scaffold will be a meaningful step towards bioprinting personalized tissues/organs for medical use.

"I enjoyed the differing perspectives of the workshops, and it reassures me knowing that no matter what my future interests are down the line, I can still have a successful career."
—2023 USRP Participant Bryan Khoo

Emma Shaw, Psychology
Mentor: Hadi Hosseini (Psychiatry & Behavioral Sciences)
Virtual Reality Assessments for the Detection of Prodromal Alzheimer's Disease
Alzheimer's disease (AD) is a common and debilitating form of dementia. Early detection of AD allows for earlier intervention and may even slow its progression. Current neuropsychological measures of AD are not effective in identifying AD in its early stages. The project Emma is working on will be one of the first to test the use of virtual reality (VR) as a tool to predict prodromal AD, comparing its efficacy to existing standard clinical assessments of AD. If successful, this study will provide a new approach to detect early memory problems in older adults using VR to assess navigation and visual spatial skills.

Julia Shaw, Psychology
Mentor: Carolyn Rodriguez (Psychiatry & Behavioral Sciences)
Suicide Attempt Risk Prediction Biomarker Study
Suicide is a major cause of death, and the suicide rate has been steadily increasing worldwide. There are no FDA-approved medications for suicide attempt prevention in non-psychotic patients. Interventions are urgently needed, as approximately 60% of individuals who complete suicide do so on their first attempt. Julia's IRB-approved project will involve using behavioral assessment and an online well-validated cognitive test battery in individuals with suicidal thoughts to test the hypothesis that cognitive control – which enables humans to flexibly switch between thought and action and to regulate perseverative thought content – may be a modifiable risk factor for underlying vulnerability for suicide attempts.



Elizabeth Hong completed her Stanford Bio-X summer research training with Dr. Catherine Blish

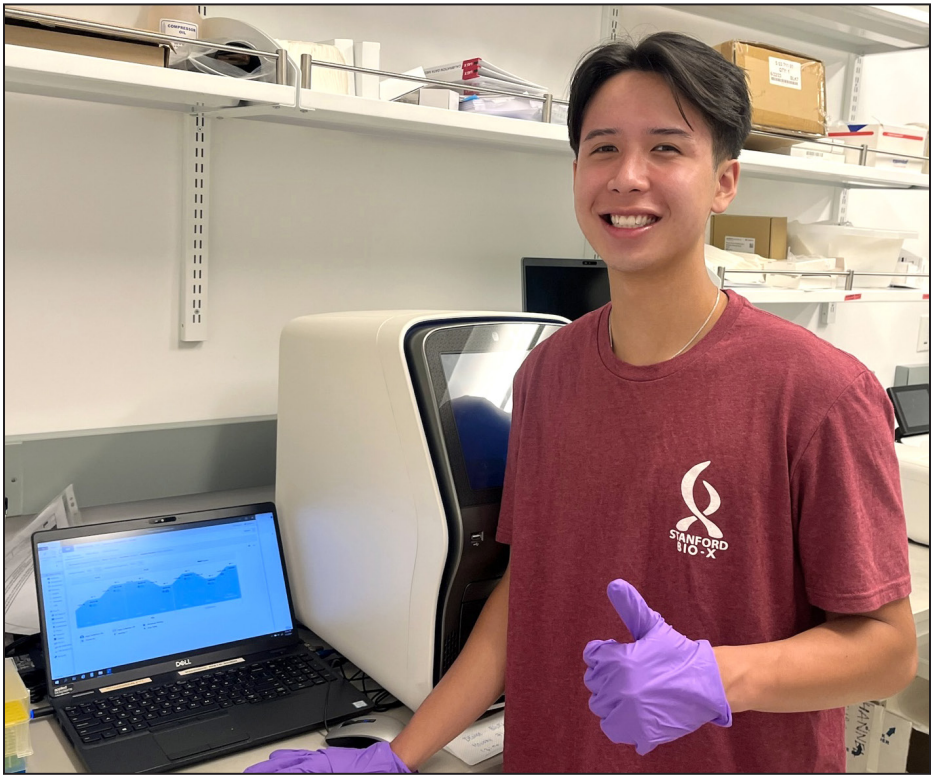
Puja Chopade completed her Stanford Bio-X summer research training with Dr. Brad Zuchero

Isabella Szabo, Mechanical Engineering
Mentor: Sarah Heilshorn (Materials Science & Engineering)
Combining GUIDE-3DP with UNION: Embedding Vasculature into Densely Cellular Tissue Via an Outside-In Diffusion Strategy for Fabrication of Perfusable Tissue Structures
Vascularization remains one of the most critical challenges in the formation of 3D multicellular structures for organ printing. In collaboration with the Skylar-Scott Lab as part of the Health Enabling Advancements through Regenerative Tissue Printing (HEART) project, the team aims to use their vasculature printing techniques with the goal of fabricating vasculature within dense cardiac aggregate tissue. In their strategy, vessels with precise and tunable dimensions are formed based on the uniform outside-in diffusion of crosslinkers from the cardioid support bath into a printed bio-ink. The aim of Isabella's project is the fabrication of fluid-perfusable structures with complex branch points and the incorporation of multiple cell types, with the ultimate goal of 3D bioprinting a human heart.

Aaron Tran, undeclared
Mentor: Nidhi Bhutani (Orthopaedic Surgery)
Investigating the Effects of Matrix Viscoelasticity on Skeletal Stem Cell Fate
Aaron's project delves into the interplay between viscoelastic properties of the extracellular matrix (ECM) and fate of a skeletal stem cell (SSC). It has been identified that ECM viscoelasticity can affect cell volume, shape, and phenotype. Aaron aims to develop a mathematical model that can act as a predictive tool for optimizing matrix properties to guide SSC fate and specific lineage commitments. The findings could advance precision in manipulating stem cell fate for targeted tissue regeneration and therapeutic applications. The ultimate goal is to provide a nuanced perspective on the influence of viscoelasticity in orchestrating the destiny of stem cells for regenerative medicine and tissue engineering.

Alexis Tran, Science, Technology, & Society
Mentor: Calvin Kuo (Medicine - Hematology)
Modeling Human Endometrial Stem Cell Biology and Tumorigenesis using Organoids
The endometrium (uterine lining) regenerates each menstrual cycle and is involved in common disorders like endometrial cancer. Using genetic engineering of patient-derived endometrial organoids, Alexis will investigate the contributions of prevalent mutations in the TP53, MYC, and PPP2R1A genes to the inception of the highly lethal serous endometrial cancer (SEC). She will specifically use prime editing, a relatively new technology, to genetically engineer organoids with the SEC-specific PPP2R1A hot spot mutation P179R. Using microscopy, omics, and xenograft approaches, she will also examine molecular and cellular characteristics of these organoids to lend insight into how cancer arises in the endometrium.

Janina Troper, Biology
Mentor: Thomas Clandinin (Neurobiology)
Utilizing SPARC for Lateralized Gene Expression in *Drosophila*
Janina's project aims to develop a new genetic tool to control gene expression unilaterally and cell-type specifically in the brain, addressing challenges posed by the bilaterally symmetric anatomy of brains. To fill this gap, she leveraged a recently developed tool for generating somatic mosaic animals, and is working to implement it early in embryogenesis. The rate of transcription, recombination and cell division are mechanisms she will explore and manipulate. Optimizing this approach allows for examination of the behavioral effects of selectively manipulating the functions of specific cell types unilaterally, creating a widely useful tool for future studies.

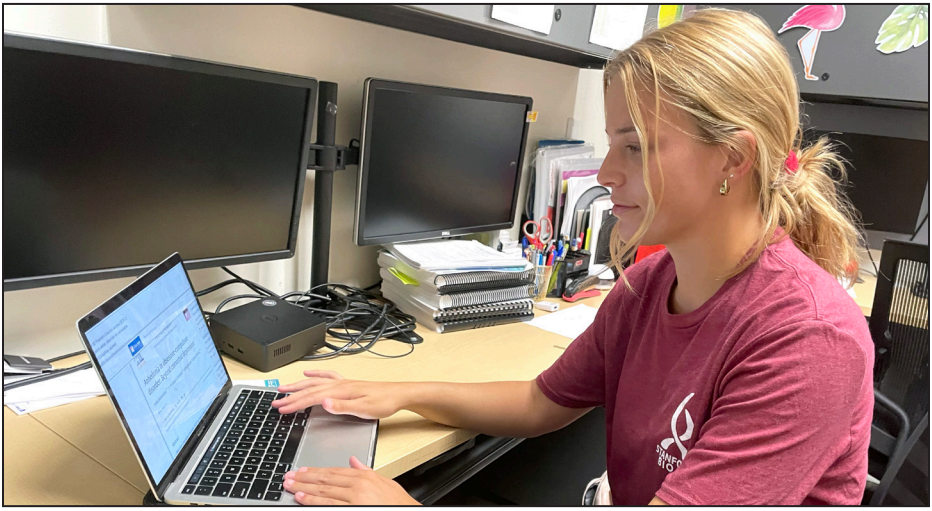


Aaron Tran completed his Stanford Bio-X summer research training with Dr. Nidhi Bhutani

Sybren van den Bedem, undeclared
Mentor: Soichi Wakatsuki (Structural Biology and Photon Science)
Potent and Selective Covalent Inhibition of the Papain-Like Protease from SARS-CoV-2
COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. Papain-like protease, or PLpro, is a viral cysteine protease found in SARS-CoV-2, vital to the virus's replication. Therefore, inhibiting PLpro is a viable way of treating COVID-19. However, effective inhibitors of PLpro may also inhibit deubiquitinases (DUBs), a protein class that regulates protein function and which includes numerous cysteine proteases. Sybren's project will be to computationally predict and experimentally test potential PLpro inhibitors for selectivity against a panel of DUBs. The goal is to identify PLpro inhibitors used as a COVID-19 treatment that are safe for human use.

Alison Wan, Engineering
Mentor: Jill Helms (Surgery - Plastic & Reconstructive Surgery)
Stem Cell Niche Response During Chronic Injury of Junctional Epithelium
The junctional epithelium (JE) is a high-turnover barrier controlled by a Wnt-responsive JE stem cell niche, protecting teeth where they attach to the gingiva. Chronic injury of the JE severely damages the JE niche, but eventually the JE begins to regenerate. Alison will study the mechanism of JE repair during chronic injury from 5-FU, a chemotherapeutic drug. The project will involve lineage tracing of Wnt-responsive cells in mice, hypothesizing that a second stem cell niche is activated to regenerate the JE. Evidence of a secondary injury-repair response could aid in discovering ways to minimize tissue damage caused by chemotherapy.

Max Scherer completed his Stanford Bio-X summer research training with Dr. Mark Skylar-Scott

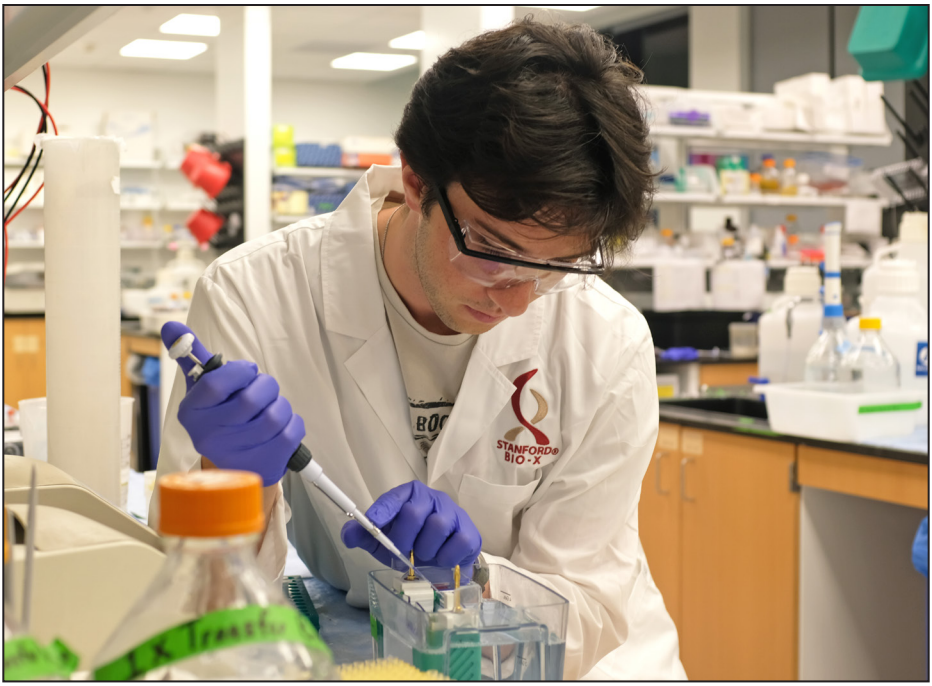


Julia Shaw completed her Stanford Bio-X summer research training with Dr. Carolyn Rodriguez

Albert Xie, undeclared
Mentor: Alice Ting (Genetics and Biology)
Development of Novel RNA-Centric Proximity Labeling, RPEX
Proximity labeling (PL) with promiscuous enzymes like APEX2 has transformed the study of protein interactions in living cells. However, its application in another important class of biomolecule – RNA – has not been widely adopted due to limited specificity and sensitivity. The goal of Albert's project is to develop a clean, broadly applicable, and generalizable PL method for RNA-centered interactome mapping. To achieve this, Albert seeks to develop "RPEX" – an evolved variant of APEX2 activated exclusively upon binding to a target RNA molecule. This technology can then be used to elucidate RNA-protein and RNA-RNA interactions involved in human diseases such as cancer.

Tyler Yang, undeclared
Mentor: Michael Snyder (Genetics)
Exploration of Various Mechanisms Behind Microbiota-Mediated Protection against Type 1 Diabetes
Type 1 Diabetes affects ~1,100,000 children globally, with incidence rising ~3% annually. The gut microbiome plays a key role in T1D pathogenesis. Certain microbial changes are hypothesized causes of seroconversion, but exact mechanisms remain unknown. Tyler's study will involve treating human immune organoid systems with specific, cultivated bacteria that exhibit anti-autoinflammation properties through both known (SCFA-producing) and unknown mechanisms. SCFA/Butyrate-producing microbes are effective in mice, but their impact on human microbiomes is currently unstudied. For other commensals, Tyler's hypothesis is that evaluating inflammation modulation through certain autoimmune-related signals (autoantibodies/cytokines) will elucidate additional mechanisms for bacteria-mediated T1D protection.

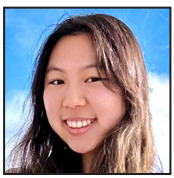
"My favorite part of the Bio-X program was the immersive learning environment that fostered collaboration among students and faculty from diverse backgrounds, enabling a deeper understanding of complex scientific challenges and innovative solutions. My participation in this program not only enhanced my technical skills but also cultivated my critical thinking, adaptability, and networking, which are all invaluable assets for my future academic and professional pursuits."
—2023 USRP Participant Kristine Pashin



David Candes completed his Stanford Bio-X summer research training with Dr. Ron Kopito

Swetha Yogeswaran, Computer Science
Mentor: E.J. Chichilnisky (Neurosurgery and Ophthalmology)
Efficacy of Wired-OR Compression in Vision Reconstruction

The goal of the Artificial Retina Project is to work towards an implantable chip to restore vision to those with incurable blindness. The lab has developed many highly successful algorithms towards this goal using recorded full bandwidth data. However, it is not feasible to get such full bandwidth data, as the power consumption of such a chip would be impossibly high for a biological system. To mitigate this problem, the lab recently developed a chip architecture that highly compresses the data, massively reducing power consumption while only reading critical values. For Swetha's project, she will develop an efficient real-time simulation of this chip for use during experimentation, analyze its efficacy for use in previously developed algorithms by comparing results to that of full bandwidth data, and eventually work towards optimizing the algorithms on this compressed data.

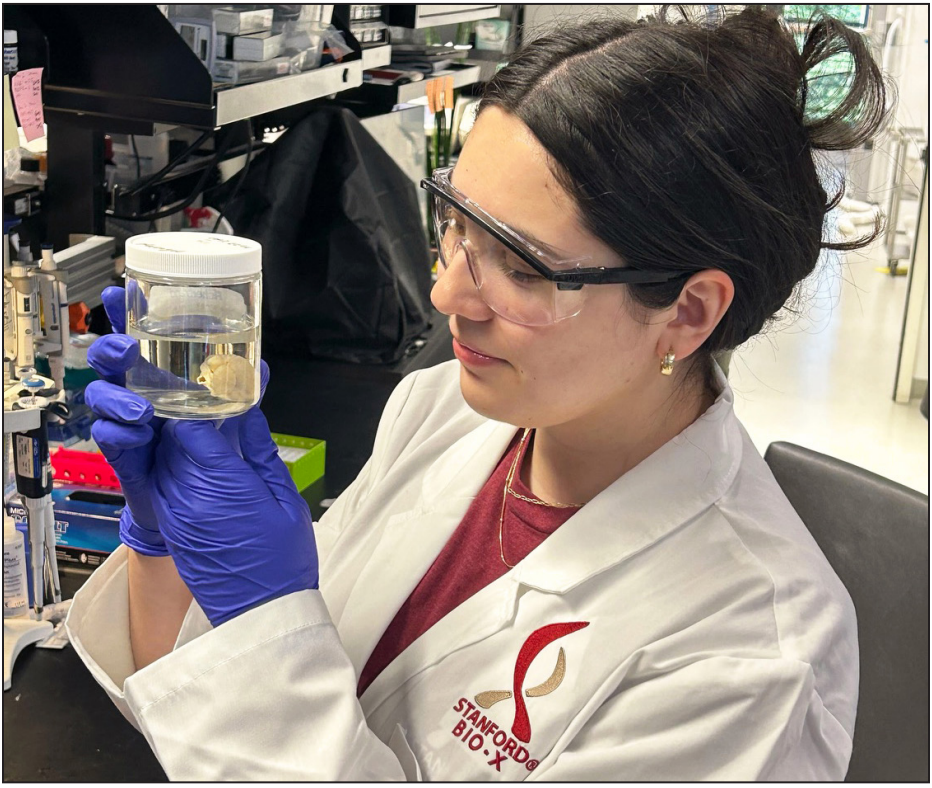


Ally Yun, undeclared
Mentor: Danielle Mai (Chemical Engineering)
Logic-Gated Self-Assembly of Protein Biomaterials

Gene replacement therapies aim to correct genetic disorders by introducing modified genes into cells. However, these modified "non-self" cells often provoke adverse immune responses, which are mitigated using potentially harmful immunosuppressants. The lab seeks to avoid these side effects by engineering non-immunogenic recombinant proteins known as elastin-like polypeptides (ELPs) to protect genetically modified cells: ELPs could self-assemble into protective coatings that shield these cells from the immune system. The lab recently demonstrated that a biological stimulus (enzyme) can induce self-assembly. This summer, Ally will engineer ELPs that undergo logic-based self-assembly in response to multiple enzymes, increasing our ability to precisely control ELP properties in complex engineered *in vivo* environments.

Carl Zhang, Bioengineering
Mentor: Philip Beachy (Urology and Developmental Biology)
Hedgehog Pathway Activation and its Regulatory Role in Adipose Tissue Fat Metabolism
Carl's project will focus on the Hedgehog (HH) pathway and its regulatory rule in adipose tissue, especially brown fat cells, which regulate body temperature. Specifically, he will use mice models to investigate the rule of HH pathway overactivation and its effect on adipose tissue. He will induce the HH pathway using Tamoxifen and measure the change in mice body weight, insulin sensitivity, and adipose tissue size. He will work on understanding the mechanism of action of the HH pathway in fat metabolism and ultimately identify a novel druggable pathway in treating diabetes and obesity.

Bowen Zheng, undeclared
Mentor: William Goodyer (Pediatrics)
Deconvolution of the Proteomic and Transcriptomic Landscape of the Human Cardiac Conduction System
Coordinated beating of the heart requires a specialized group of cells known as the cardiac conduction system (CCS), essentially the electrical wiring of the heart. The CCS is critical for the heart's normal function and development, however, much remains unknown of the molecular regulators that govern the CCS. Bowen's research project will employ both single-nucleus RNA sequencing and, in collaboration with the Lundby lab in Denmark, proteomics of previously isolated human conduction tissue to provide a first-in-kind, comprehensive gene and protein expression atlas for facilitating future efforts in conduction cell identification and characterization in the context of development and disease.



Lauren Reyes completed her Stanford Bio-X summer research training with Dr. Kristy Red-Horse

2024 Stanford Bio-X Undergraduate Summer Research Program Cohort Leads:

Ari Arias, Biology
Mentor: Helen Blau (Microbiology & Immunology)
15-PGDH Inhibition Recovers Muscle Strength in Murine Models of Muscle Unloading
The Blau lab discovered that the protein 15-PGDH accumulates with age and drives aging-associated muscular loss. "Unloading" is a technique that induces muscle loss by preventing lower limb movement, similar to a cast. Ari will use this model to test whether deactivating 15-PGDH lessens the muscle loss that comes from unloading, especially in aging. Ari will perform unloading experiments on treated and untreated aged and young mice, and analyze their muscle and nerve tissues and muscle strength and endurance. If deactivating 15-PGDH helps lessen the muscle loss caused by unloading, it will help people recover more quickly from diseases and injury.

Ireh Kim, Biology and Music
Mentor: Helen Blau (Microbiology & Immunology)
Inhibition of the Gerozyme 15-Pgdh Rescues Skeletal Muscle Overload Response in Aged Mice
Weight-lifting and other resistance training use high-force contractions, or "mechanical overload," to trigger muscle growth. However, both muscle mass and the ability of muscle to respond to overload reduce with age. Previously, the Blau lab showed that a protein called 15-PGDH accumulates with aging, and that, in mice, deactivating this protein improves aged muscle size and function. Ireh's project is to determine if deactivating 15-PGDH also improves response to overload. Ireh's preliminary data suggests that treated aged mice subjected to overload have better muscle mass and composition than controls. Her findings suggest deactivating 15-PGDH as a therapy to rebuild aged muscle.

Noah Lowe, Symbolic Systems
Mentor: Keren Haroush (Neurobiology)
Using Machine Learning to Classify Marmoset Behavior in Social Decision-Making Games
In order to understand the fundamental building blocks of social decision making, the team will analyze marmoset monkeys playing through social dilemma games that test one monkey's altruism towards another. They use machine learning to objectively characterize each monkeys' behavior throughout these games, using AI to automatically classify behavior across video frames. By understanding the monkey's behavior in conjunction with its decision making and neural activity, they may be able to unravel the neuronal basis for human social decision making.

Vivian Tien, Bioengineering
Mentor: Paul Khavari (Dermatology)
The Energy-Independent Role of Glucose in Adipogenesis
Metabolic diseases such as Type 2 diabetes and fatty liver disease affect millions worldwide. Previous work in the Khavari Lab has shown that glucose not only acts as an energy source but also directly binds to proteins to change their function, regulating metabolism. The lab has discovered a glucose-binding protein – TSC22D4 – which is involved in insulin response. Vivian's project will apply biochemical assays and cell cultures to study the role of glucose-TSC22D4 interactions in the formation of fat cells, a process heavily affected by metabolic diseases. She hopes to show how glucose accumulation is not a consequence of metabolic disease, but a cause.

Workshops on Research Skills:

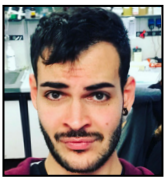
In 2024, Stanford Bio-X hosted 4 workshops for the Undergraduate Summer Research Program cohort. The workshops are designed to help the students grow as researchers, discover new tools, and identify skills and techniques to help maximize their summer learning.

The workshops, led by a team of Stanford Bio-X research scientists (pictured below), are scheduled throughout the program to guide and prepare the undergraduate students. The workshop moderators gain valuable teaching and presentation practice, as well as becoming a part of the student cohort's network, acting as a valuable resource for advice and future mentorship, both in terms of the topics covered and the students' future careers.

Scientific Literature: How to Find, Read, Analyze, and Cite

Led by Dr. Maja Djurisic

This workshop discusses the strategies for finding scientific publications of interest and the way publication's stereotypic organization is used for efficient but critical reading of presented work. It covers the rules guiding the proper citation of existing literature. Software tools used to consolidate publication search results, and retrieval while writing/citing, such as EndNote and Zotero, are discussed at the end.



Mastering Research Design: What to Do for Developing Strong Research Projects

Led by Dr. Andrea Cipriano

This workshop focuses on key questions and essential steps necessary for crafting an impactful research project. It offers hands-on examples and engaging exercises designed to equip students with critical insights and skills for undertaking research endeavors in different fields of biology.

Oral Presentation Skills

Led by Dr. Annina Sartor

This workshop is focused on finding clear and brief ways to communicate your science both in formal settings (at conferences, poster sessions, and research meetings) and informally (to colleagues and other students). Participants practiced "elevator pitch" summaries of their summer projects and learned how to keep in mind the key message and target audience when planning longer oral presentations.

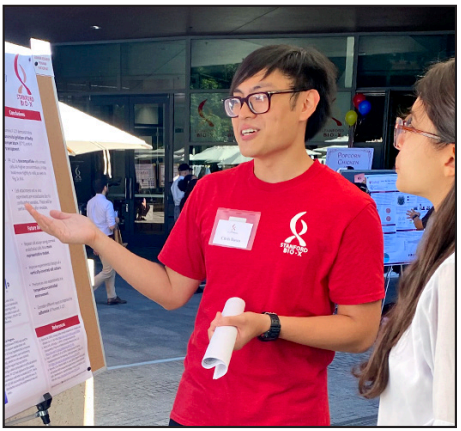
Poster Design: Presenting Your Data

Led by Dr. Annina Sartor

How do you decide to graphically represent your data? How do you think about the conclusions your audience will draw when looking at your poster? This workshop covers scientific poster design, practical tips for making a poster from scratch using available software, and advice on how to present the finished product at a poster session.

"One way or another, all Bio-X workshops and panels... developed my perspective of pursuing research in the future. My journal club strengthened my ability to explore and efficiently understand a diverse range of scientific papers, all the while making me excited to learn more about the latest science! The speaker series served as an amazing window into the lives of so many different researchers with a diverse range of projects and backgrounds. I am inspired to keep learning more and more about science as a whole."

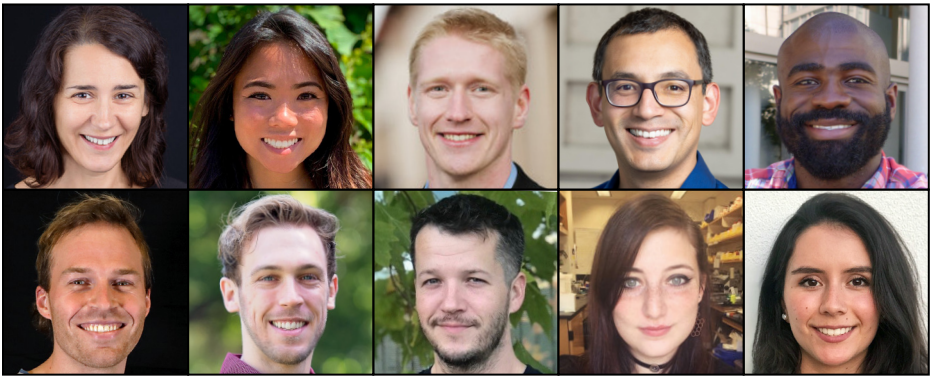
—2022 USRP Participant and 2023 Cohort Lead Chris Basco (pictured at right)



Journal Clubs:

The cohort students participate in journal club meetings to read and analyze scientific manuscripts related to their discipline of research. These 10 journal clubs also offer opportunities for them to collaborate in small groups and lead discussions about journal articles within their field of interest. The journal clubs are guided by Stanford graduate students, postdocs, and research scientists to provide intellectually challenging journal articles and to help facilitate high-level analysis, which also adds teaching and leadership experience to the journal club leaders' training at Stanford.

Journal Club Mentors:



Neuro-immune Interface

Led by Dr. Maja Djurisic

As a consequence of historically compartmentalized academic disciplines, nervous and immune systems have been thought of as functionally independent from each other. We will explore new work refuting the dogma that brain is an immune-privileged organ, and show new work on the bidirectional communication between the two systems. We will see that immune system influences brain and synaptic development and brain aging, and vice versa that the nervous system coordinates the immune system's reaction to invading pathogens. Shared molecular mechanisms depict a joint evolutionary history that informs how the two systems function interdependently in both health and disease.

Health Psychology and Technology

Led by Dr. Cassie Eng

We will discuss cyberpsychology – the emerging field of how the culture of technology (social media, virtual reality, the internet, mobile devices, video games) affect the brain, behavior, and wellbeing. As mobile phone accessibility, video games, and social media use grow exponentially, understanding the effects of various human-technology interactions on neurological, cognitive, and physical health is of crucial importance. It is clear technology is here to stay, and we will focus on papers addressing how evidence-based technology grounded in psychology and health neuroscience theories is capable of enriching – not hindering – the physical and mental wellbeing of individuals.

Mitochondria: Powerhouse or So Much More

Led by Douglas Henze

The fields of biochemistry and cell biology alike have long identified mitochondria as 'the powerhouse of the cell', but is that all they are good for? Mitochondria are unique in that they have their own genome separated from the rest of the cell and can carry out functions, besides ATP generation, that are necessary for the survival and eventual death of all cells. We will investigate the origin, and diverse array of functions that mitochondria posses, including metabolic regulation, cell cycle control, and apoptosis regulation.

Synthetic Immunology in Cancer

Led by Dr. Daniel Alexander Hoces Burga

This interactive forum is dedicated to exploring the cutting-edge field of synthetic immunology and its applications in cancer research. We will engage in discussions and learn from key publications that harness the power of synthetic biology to revolutionize cancer immunotherapy. In addition to gaining a fundamental understanding of immunology, our goal is to unravel the innovative strategies employed in engineering immune cells, which are paving the way for personalized and precise cancer treatments.

Malfunctioning Molecular Machines in Aging

Led by Dr. Kojo Opoku-Nsiah

We will examine the cellular mechanisms of aging and how misregulation of the protein homeostasis (proteostasis) network potentiates aging and age-associated diseases. Papers will focus on the molecular machines that govern proteostasis, the downregulation of their respective processes, and the consequential impact in aging. Topics will include: chemical biology, biochemistry and cell biology.

Journal Clubs (Continued):

3D Bioprinting
Led by Fredrik Solberg
17 people die every day while awaiting organs for transplantation, and a new person is added to the transplant waiting list every nine minutes. For patients fortunate enough to receive organ transplants, long-term usage of immunosuppressive drugs is needed to prevent rejection. 3D bioprinting holds great potential to fabricate personalized and complex tissues from autologous cell lines, offering a potential solution to the organ shortage crisis. We will discuss seminal publications and investigate current successes and limitations of 3D bioprinting, focusing on various strategies of 3D bioprinting, material selection, cellular proliferation and remodeling, engineered tissue vascularization, and candidate organs.

Advancing Human Performance
Led by Jon Stingel
Our Biomechanics Journal Club offers a specialized focus on cutting-edge computational and experimental methodologies driving advancements in human movement biomechanics. This segment delves into the capabilities of human movement, avenues for augmentation, and strategies for optimizing human performance. We will examine state-of-the-art research and explore the intricate interplay between biomechanical principles and human performance enhancement. Topics include the biomechanics of elite athletic performance, innovations in wearable and statistical modeling technology for movement analysis, and the development of assistive devices.

Neuron-Glia Interactions
Led by Dr. Justin Trotter
We will dig into the growing field that covers the intersection of glia and neurons. Glia are fundamentally important for brain function at many levels, and it is increasingly clear that they perform critical roles (and not just support functions) in the normal and diseased brain. In fact, many of the molecules (and diseases) that have been primarily attributed to neuronal dysfunction (e.g. schizophrenia and autism) may be also due to glial dysfunction. We will not discriminate against types of glia – all are welcome (and so are neurons).

Stress Responses
Led by Alex Catherine-Nicole Van Elgort
We will aim to discuss papers around elucidating molecular mechanisms of cellular stress responses and adaptation. This can range from genotoxic stress, to proteotoxic stress and more!

Immunomodulatory Biomaterials for Tissue Repair
Led by Cassandra Villicana
We will cover papers that use biomaterials to modulate the immune system towards a regenerative response. Our aim will be to discuss and study immune cells which interact with biomaterials and focus on methods towards engineering biomaterials to harness the immune system to boost tissue repair.

" I really really really enjoyed the journal club series. I read a lot of challenging papers but also learned a lot more about other fields of biology… I had a great time!"
—2023 USRP Participant Esther Tok

2013 Stanford Bio-X Undergraduate Summer Research Program Participants

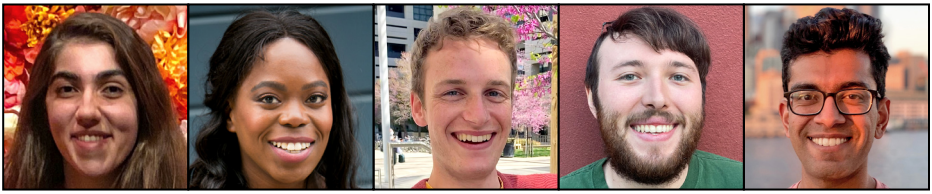
Professional Networking Events:

Participating in the Bio-X Undergraduate Summer Research Program confirms the chosen career paths of some students and opens up new avenues to explore for others. Members of the Bio-X community were invited to engage with our cohort at two separate events. Who better to talk with the students than people who were once in these students' shoes?

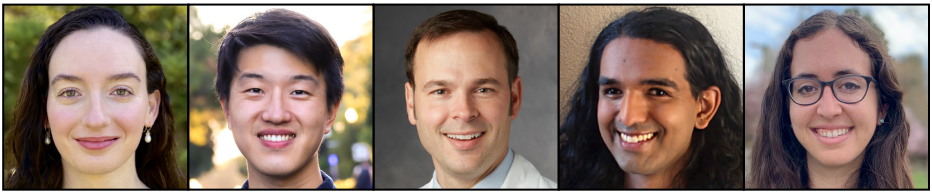
Professional Path Meet and Greet:

This year, ten Bio-X PhD fellows – in fields such as biology, electrical engineering, bioengineering, chemistry, chemical engineering, biophysics, immunology and more – were invited to breakfast with our cohort for an opportunity to informally gather and discuss anything and everything about the PhD and MD experience.

Panelists:



Nahal Bagheri | Cecelia Brown | Mark Fleck | Jacob Horne | Karan Kathuria



Danielle Klinger | Daniel Liu | Dr. Andreas Loening | Adi Mukund | Abby Thurm

Abby Thurm with 2024 USRP participants

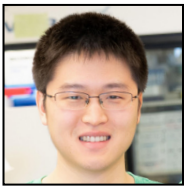
Dr. Andreas Loening with 2024 USRP participants

Karan Kathuria with 2024 USRP participants

Professional Panel Discussion:

Three Bio-X USRP alumni – in academia, medicine, and industry – were invited to have a conversation with our cohort, to answer questions, and to share ideas.

Panelists:



Dr. Alex Gao participated in the USRP in 2010 and is now an Assistant Professor of Biochemistry at Stanford. Alex received a B.S. in chemistry and an M.S. in electrical engineering from Stanford, and a Ph.D. in biological engineering from MIT and the Broad Institute. Alex's lab at Stanford focuses on harnessing the genetic diversity of microbes, with the goal of developing new molecular technologies for health and medicine.

Dr. Cheri Wu, 2010 USRP cohort, is now a practicing psychiatrist. Cheri is a licensed physician in California and double-board certified in General Psychiatry and Child & Adolescent Psychiatry by the American Board of Psychiatry and Neurology. She completed both her General Psychiatry Residency and Child & Adolescent Psychiatry Fellowship at Stanford School of Medicine. She works 3 days a week in private practice to have the ability to provide high quality care to patients and achieve a better work-life balance.

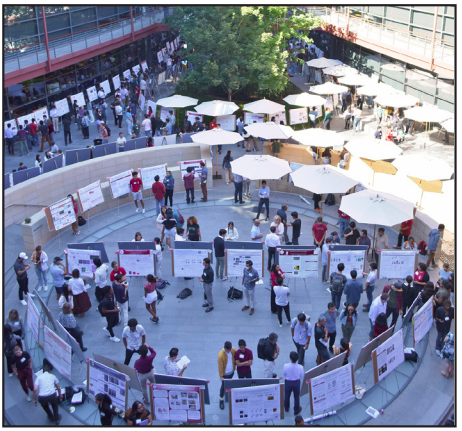
Everett Frost, USRP 2011 and 2012, is now a Portfolio Manager and Founder. Everett graduated from Stanford with a BS in Bioengineering, where he received the Firestone Medal for excellence in undergraduate research. He holds an MBA from Harvard Business School. Everett founded Mabery Investment Partners, an investment firm that runs a concentrated public equities portfolio focused on technology, healthcare, and financial services businesses.

"The panel on careers is extremely helpful since I am between pursuing research, medicine, or biotech. It is helpful to understand the journey that professors and other industry leaders take through their careers."
—2023 USRP Participant Abhinav Kumar

Scientific Poster Session:

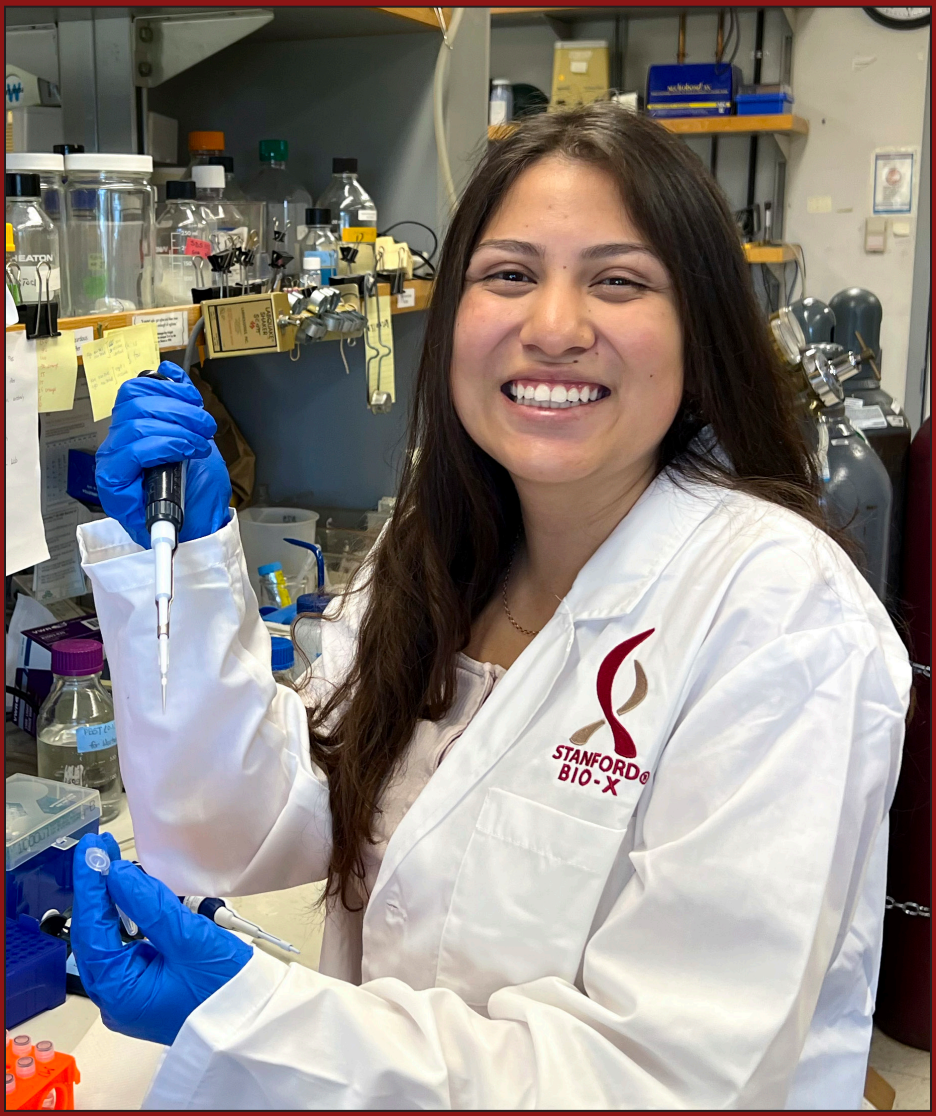
On August 29th, the cohort will present their posters at the Stanford Bio-X Interdisciplinary Initiatives Seed Grants Program Poster Session, which will include over 260 scientific posters from Stanford faculty, postdocs, graduate students, research scientists, and other undergraduates!

2023 USRP Participant Kristine Pashin presenting



2023 Stanford Bio-X Poster Session

Stanford Bio-X Undergraduate Summer Research Program



Iliana Nava will complete her Stanford Bio-X summer research training with Dr. Margaret Fuller

https://biox.stanford.edu
To learn more, please email us at:
contact-biox@stanford.edu