

STANFORD BIO-X UNDERGRADUATE SUMMER RESEARCH PROGRAM



“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



2019 Undergraduate Summer Research Program (USRP) Participants

In Summer 2022, the Stanford Bio-X Undergraduate Summer Research Program enthusiastically welcomed our **full cohort** of 73 exceptional Stanford students back to research in laboratories across the campus. 85 Faculty, students, and staff from 34 departments and Stanford Bio-X Institute contributed their time and effort to the talks, workshops, journal clubs, and other events that enriched the 18th year of the Stanford Bio-X Undergraduate Summer Research Program. More than ever, to make up for the lost in lab research time for students due to COVID, Stanford Bio-X was committed to creating a vigorous, valuable, and fulfilling in-person research experience to fast track the sharpening of students' skills and techniques. Since 2006, the Stanford Bio-X has provided a ten-week summer research opportunity to a total of 856 students.

In addition to supporting students to conduct full-time research during the summer, Bio-X enlisted assistance from its Stanford community in order to incorporate unique interactive and collaborative experiences for the cohort. 18 Bio-X postdocs, graduate students, researchers, and senior-level undergraduates 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 each Wednesday during the 10-week program):

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.

6 Workshops (offered in the spring and summer quarters):

Throughout the program, workshops explore a variety of research-related skills, including how to analyze manuscripts, how to formulate scientific questions, how to design experiments, how to give oral presentations, and more. In addition to the undergraduate cohort receiving valuable training, the graduate students and postdoctoral fellows who develop these workshops gain the opportunity to practice their teaching and presentation skills and collaborate with one another on programming content. The workshops also become a resource for the summer cohort for broader career and research advice by expanding their network of colleagues at Stanford.

Journal Clubs (10 groups exploring different topics met for 5 consecutive weeks):

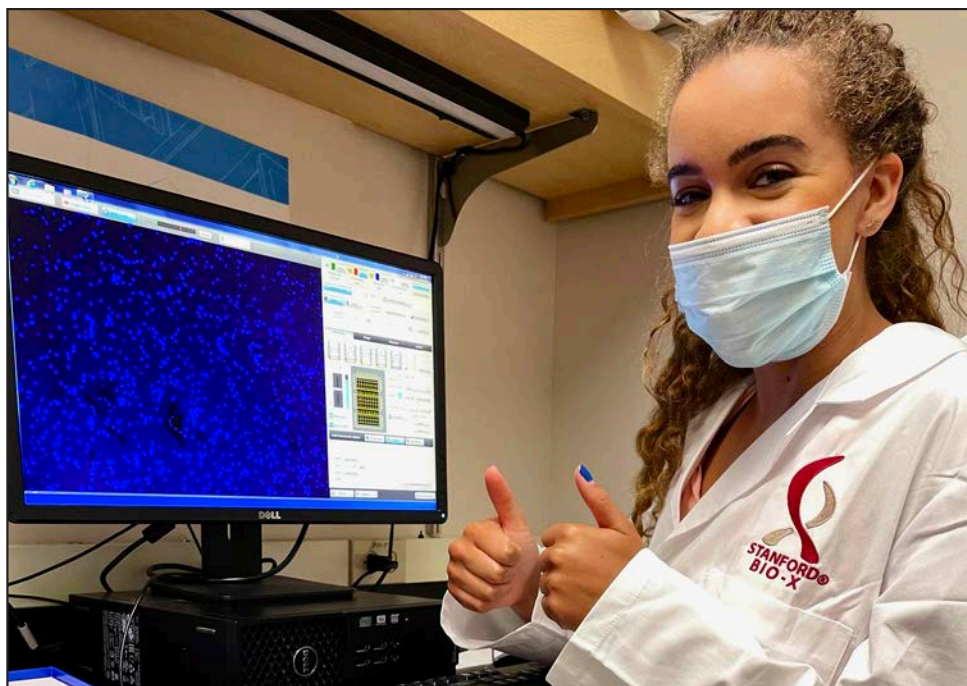
The journal club series facilitate critical thinking among the students as they work in small groups to lead intellectually rigorous discussions regarding recent publications, innovations, and challenging scientific problems. Reading, understanding, and sharing insights from published manuscripts is 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.

Poster Session:

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 Paramitas Foundation, Winston Chen and Phyllis Huang, The Rose Hills Foundation, Jane and Owen Frost, Pitch and Cathie Johnson, Brian and Karen Mariscal in honor of Judy Pinsker-Smith, Vicky and David Rogers, Stanford Bio-X, and Anonymous Donors.



Alanna Dorsey will complete her Stanford Bio-X summer research training with Dr. Marion Buckwalter

Alumni Comments:



"All of the workshops were so well put together and thought through, I learned so much from people's experiences and their research. Also, my mentor did such an amazing job teaching me wet lab techniques. I learned so much!"

—2021 USRP Participant Khaing Mon

"The summer undergraduate research allowed me to gain experience in the use of virtual reality platforms and their impact on human cognition. The project further broadened my understanding of various methods for setting up experimental research and logging quantitative data on human behaviors. It has encouraged me to look for technological applications in my future endeavors related to health and medicine."

—2019 USRP Participant Marlon Washington II



"After really focusing time on a project and also becoming involved in other studies going on at the lab, I realize[d] how research allows you to learn things you never expected to. From random facts to understanding how other scientists may think when it comes to reviewing papers to learning how to communicate with others, I find research to be something I enjoy doing... And I really feel like I can apply research in my future aspirations to become a physician."

—2016 USRP Participant Grace Tam, now a Clinical Research Coordinator at Stanford University

"Bio-X was a great experience for me. Between my sophomore and junior year I was able to work on a meaningful research project that really helped propel my career in medicine. The program was a launching pad for my pursuit in medicine and surgery. I'm happy to know that the program continues to give undergraduate students an opportunity to get deeply involved in a research project of their choosing."

—2010 USRP Participant Jeremy Goodman, now a resident physician at the University of Wisconsin, Madison



"My Bio-X USRP experience built my undergraduate research project, forming the basis for my honors thesis. The program also gave me the confidence in my research skills needed to apply my training the following summer as an intern in oncology drug development at Genentech. These early work experiences were critical preparation for my PhD in biomedical sciences and helped launch my career in biotech."

—2008 USRP Participant Cameron Pitt, now the Chief Business Officer at Quanta Therapeutics



2016 Undergraduate Summer Research Program (USRP) Participants

Recent Alumni Updates:



2020 Stanford Bio-X Undergraduate Summer Research Program Participant Helena Zhang (right) with Dr. Michelle Monje

Beth Griffiths, 2008 cohort (right), is an assistant professor of medicine at the University of California-San Francisco. She teaches health policy, advocacy, and community engagement and collaborates with researchers to translate their work into policy change, and she is an internal medicine physician who provides primary care to adults and teaches medical students and residents in primary care clinic.



Brian Aguado, 2009 cohort (left), is an Assistant Professor of Bioengineering at UC San Diego, where his laboratory studies sex differences in cardiovascular disease using biomaterial technologies. Dr. Aguado's postdoctoral fellowship at the University of Colorado Boulder received awards from the National Institutes of Health and Burroughs Wellcome Fund. He also co-founded LatinXinBME, a social media initiative dedicated to building a diverse and inclusive community of Latinx biomedical engineers and scientists.

Raman Nelakanti, 2011 and 2013 cohorts (right), is completing his MD-PhD at Yale School of Medicine, studying the function of a newly discovered epigenetic mark in stem cell fate decisions. Raman was a lead author on a 2020 publication in *Nature*, with co-authorship on numerous other manuscripts, and is pursuing a physician-scientist career at the intersection of epigenetics, stem cell biology, and human disease.



Alex Greaves, 2012 cohort (left), is the co-founder of FlutterFlow, which makes building mobile apps easier for designers, developers, and entrepreneurs. FlutterFlow has a simple drag-and-drop interface so users can build a fully functioning app in as little as an hour. FlutterFlow received a Golden Kitty Award from Product Hunt and is backed by the Y Combinator startup accelerator. Previously, Alex also co-founded Taste, Inc., a customer rewards and food discovery platform.

Lila Neahring, 2013 cohort (right), is a graduate student in the Dumont lab at the University of California-San Francisco. She is a Hertz Fellow, NSF Graduate Fellow, and UCSF Discovery Fellow. She is interested in organelle dynamics during mitosis, and also in self-organization at multicellular scales.



Cole Deisseroth, 2017 cohort and 2018 cohort lead (left), is a recipient of the prestigious 2021 Child Neurology Foundation Neurodevelopmental Disabilities Scholarship for his research project on EBF3-related disorders conducted in the lab of Dr. Hsiao-Tuan Chao (Baylor College of Medicine).

Helena Zhang, 2020 cohort (above), just graduated from Stanford, with plans to attend medical school to become a doctor who integrates art into her work to make patients feel safer and more comfortable. She continued studying malignant synaptic plasticity in brain cancer in Dr. Michelle Monje's lab after her USRP experience and also held art workshops, as well as creating an original coloring book for youth and families in public housing and shelters.



Francesca Kim, 2020 cohort (left), was awarded a Barry Goldwater Scholarship to support her research career. Francesca also received a Strauss Scholarship to expand Healing Strokes, an art therapy program she founded for stroke survivors and caregivers. She hopes to pursue an MD/PhD to develop novel technologies for treatment of brain disorders and to conduct research and teach at the university level.

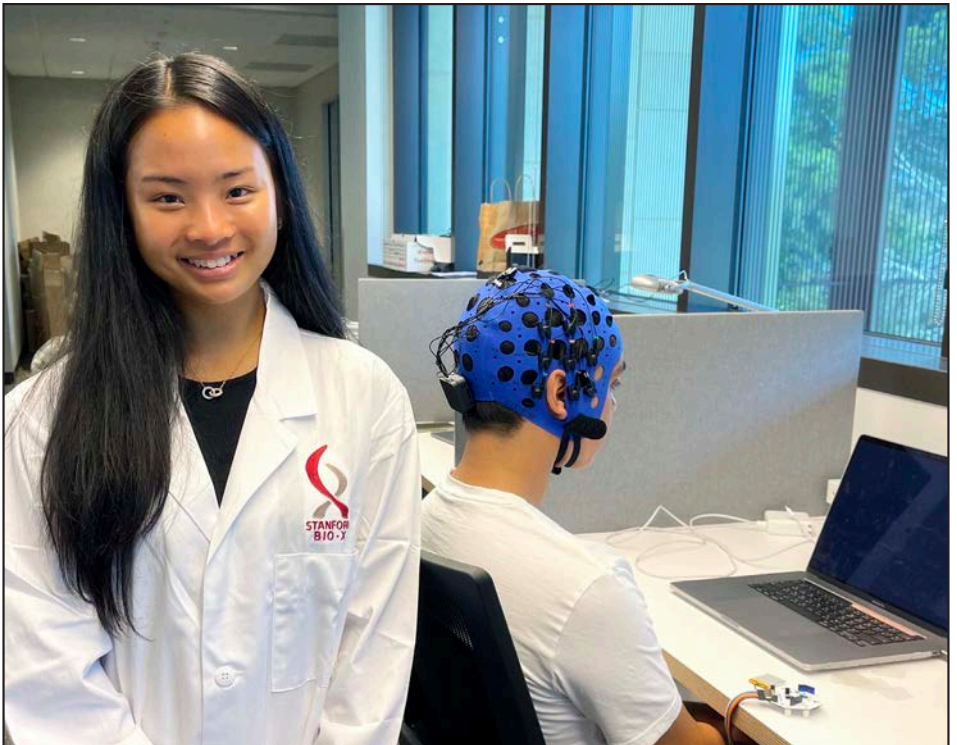
Stanford Bio-X Undergraduate Summer Research Program Alumni:

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, Epitome Biosciences, Fancy That, Benchling, Stronger Brains, and many other innovative startups and non-profits at the intersection of science, technology, and health



2018 USRP Participant Kevin Tien in Dr. Russell Fernald's lab



Irawadee Thawornbut will complete her Stanford Bio-X summer research training with Dr. Todd Coleman

2022 FACULTY TALKS FOR THE STANFORD BIO-X UNDERGRADUATE RESEARCH PROGRAM

June 22

Natalia Gomez-Ospina (Pediatrics - Medical Genetics and Stem Cell Transplantation), "Engineering the blood to treat the brain"
Jason Yeatman (Pediatrics, Education, and Psychology), "The Neural Circuitry of Literacy"
H. Craig Heller (Biology), "Fixing the Learning Disability Associated with Down Syndrome"

June 29

Fan Yang (Orthopaedic Surgery and Bioengineering), "Engineering Biology through Biomaterials Design: from Tissue Regeneration to Modeling Cancer"
Todd Coleman (Bioengineering), "Monitoring the Electrical Patterns of the Human Digestive System"
Danielle Mai (Chemical Engineering), "Calcium-Responsive Proteins as Muscle-Mimetic Materials"

July 6

Ravindra Majeti (Medicine - Hematology), "The Development of CD47 Antibodies in Myeloid Malignancies"
Onn Brandman (Biochemistry), "Cellular Stress Responses"
Juliet Knowles (Neurology & Neurological Sciences and Pediatrics - Operations), "Pediatric Epilepsy: Could Myelin Be an Unexpected Culprit?"

July 13

Jose Parvizi (Neurology & Neurological Sciences), "Exploring the Human Mind with Intracranial Recordings and Electrical Stimulations"
William Giardino (Psychiatry & Behavioral Sciences), "Extended Amygdala Neuropeptide Circuit Mechanisms of Emotional Arousal"
Dennis Wall (Pediatrics - Systems Medicine and Biomedical Data Science), "Innovation in Healthcare"

July 20

Steven Banik (Chemistry), "Development of Next-Generation Therapeutic Modalities"
Kara Davis (Pediatrics - Hematology & Oncology), "Predicting Patient Outcomes from Single Cells in Childhood Cancer"
Richard Frock (Radiation Oncology - Radiation & Cancer Biology), "Cutting and Pasting: DNA Repair Artistry in Non-Cycling Cells"

July 27

Karla Kirkegaard (Genetics and Microbiology & Immunology), "Viral Evolution"
Gen Shinozaki (Psychiatry & Behavioral Sciences), "Game Changing Approach for Delirium: Bispectral EEG (BSEEG) for Detection of Delirium and Prediction of Patient Outcomes"
Matthew Porteus (Pediatrics - Cancer Biology), "Advancing Homologous Recombination Based Genome Editing of Hematopoietic Stem Cells"

August 3

Laura Prolo (Neurosurgery), "Molecular Mechanisms of High-Grade Glioma Invasion"
David Relman (Medicine - Infectious Diseases and Microbiology & Immunology), "Human-Microbe Relationships"
Kwabena Boahen (Bioengineering and Electrical Engineering), "Silicon Brain: The Future of Artificial Intelligence"

August 10

Michelle James (Radiology and Neurology & Neurological Sciences), "Detecting and Tracking Immune Responses in the Brain and Beyond Using PET"
Soichi Wakatsuki (Photon Science Directorate and Structural Biology), "How SARS-COV2 Proteases Interact with Human Host Cell Proteins"
Kerwyn Casey Huang (Bioengineering and Microbiology & Immunology), "Thinking Small"

August 17

Lauren O'Connell (Biology), "Ecological Tuning of Animal Physiology and Behavior"
Yang Sun (Ophthalmology), "Gene Therapy in Treating Blindness: Optic Nerve and Retinal Regeneration"
Hunter Fraser (Biology), "Using Hybrids to Reveal What Makes Us Human"

August 24

Daniel Jarosz (Chemical & Systems Biology and Developmental Biology), "Epigenetics Beyond the Chromosome"
Calvin Kuo (Medicine - Hematology), "Using Organoids to Model Human Disease"
Birgitt Schuele (Pathology), "Human iPSC Tool Box for Modeling of Parkinson's Disease"

Workshops on Research Skills:

In 2022, Stanford Bio-X is hosting 6 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 graduate students and 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 collaborating collectively to develop rigorous and meaningful workshop content.

The session leaders also become 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.



Dr. Maja Djurisc

How to Approach Scientific Literature: From Finding, Through Reading, to Citing

This workshop begins with a discussion of strategies for finding scientific publications of interest. Organization of a scientific publication will be examined in the context of critical but efficient reading of presented work. Tools to save and organize publication search results into your own "database" from which to cite published work will be covered.



Caitlin Maikawa

Experimental Design Strategies

This workshop gives an introduction to how to begin designing a research project. Caitlin discusses how starting from their project proposals, students can identify their research goal, and determine their hypothesis or engineering approach. Students will then workshop how to start designing an experiment to achieve their research goal and what experimental controls are needed.

Tools and Best Practices for Data Collection and Analysis

This workshop gives an introduction to best practices for effectively recording data and tools that students can use to record experimental details and do analyses. Caitlin will discuss keeping a lab notebook, considerations for reproducibility, digital tools that can be used to help with record keeping, and provide a brief overview of different tools that are available for analyzing and visualizing data.



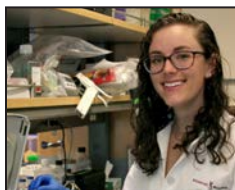
Annina Sartor

Oral Presentation Skills

As a scientist, you'll frequently have to verbally communicate your thoughts and results both in formal settings (at conferences, poster sessions, and research meetings) and informally (to colleagues and other students). In this research, Annina will help students workshop their "elevator pitch" summaries of their summer projects and learn how to keep in mind the key message and target audience when planning oral presentations of any length.

Figure Design: Visualizing Your Data

You did it! Your experiment finally worked and you're ready to show off your data at a research meeting or in a scientific publication! But how do you decide to represent your data? How do you think about the conclusions your audience will draw when looking at it? How do you make it pretty and ready for print? In this workshop, Annina will discuss the choices made when designing a figure based on a dataset, highlight some available software tools, and share some practical skills for designing Powerpoint Slides to support verbal presentations.



Nina Horowitz

Scientific Writing

Nina will use this workshop to explain the basics of effective scientific writing. By the end of the session, students will be equipped with a rigorous understanding of the structure and content of abstracts, research summaries, and scientific proposals. The workshop will also include time to practice editing written content.

Journal Clubs:

The cohort students participate in journal club meetings to read and analyze scientific manuscripts related to their discipline of research. These 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.



Suhaas Anbazhakan

Cardiovascular Mechanics and Hemodynamics

We will analyze and discover the forces within the cardiovascular system that affect normal physiology and abnormal pathophysiology. Papers in this field will utilize fundamental principles in physics and mathematical modeling to quantitatively describe blood flow, cardiac contractility, and vascular remodeling.



Dr. Maisie Lo

Optogenetics: Neuromodulation via Genes & Light to Control Neurons

We will delve on topics related to optogenetics, a revolutionary technology used by neuroscientists all over the world. Papers will focus on how and why this technology is so powerful with emphasis in molecular engineering, neuroscience and bioengineering approaches.



Dr. Gaetano D'Amato

Cardiovascular Development and Heart Regeneration

We will study cardiovascular biology with a special focus on developmental pathways important for cardiac morphogenesis. We will discuss papers related to cardiac injury and understand whether reactivation of developmental pathways can ameliorate heart function in injured heart.



Dr. Aram Raissi

Neurodevelopmental Disorders

We will focus on neurodevelopmental disorders such as Autism and Intellectual Disabilities. We will examine how behaviors relevant to ASD and ID are studied in animal models and associated with synapse dysfunction and aberrant circuit formation in the developing brain.



Dr. Maja Djurisic

Endocannabinoid System

Endocannabinoid (eCB) system is found across different organs, including brain, lung, immune-, reproductive-, and cardiovascular systems. Through synaptic, juxtacrine and paracrine action, it is responsible for maintaining homeostasis. In this journal club, we will learn about the normal function of the eCB system, its interaction with phyto-cannabinoids like THC, and its links to disease states.



Dr. Justin Trotter

Neuron-Glia Interactions

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).



Dr. Andrew Groll

Engineering Radiation Detection Systems

We will cover papers which implement different methods for radiation detection in applications such as medicine and security. Medical topics will include non-invasive imaging whereas security will focus on remote sensing using drones.



Alex Catherine-Nicole Van Elgort

Stress Responses

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!



Dr. Jeremy Leitz

Neuron Communication...at the Molecular Level!

We will cover papers which implement different methods for radiation detection in applications such as medicine and security. Medical topics will include non-invasive imaging whereas security will focus on remote sensing using drones.



Lucy Wang

Mechanics of Nerve Repair

We will discuss strategies for repairing peripheral nerve injuries, focusing on the role of mechanical forces in determining repair outcomes.

2022 Stanford Bio-X Undergraduate Summer Research Program Participants:

Pooja Akella, undeclared

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

Elucidation of the HIPK4-Dependent Phosphoproteome in Round Spermatids



Homeodomain-interacting protein kinase 4 (HIPK4) is essential for male fertility in mice and is predominantly found in developing sperm cells. The Chen lab has established HIPK4 as a key regulator of sperm head shaping, but the molecular mechanisms underlying this process are unknown. Pooja will address this question by performing comparative analysis of cell signaling in both sperm cells with and without the HIPK4 gene. To do this, she will purify populations of round sperm cells from mice using gravity sedimentation and fluorescence microscopy. Pooja will then process these cells using chemical and biochemical techniques, and submit them for phosphoproteomic analysis. Results will elucidate how HIPK4 is molecularly involved in sperm cells development.

Sebastian Alfonso, Human Biology

Mentors: Onn Brandman (Biochemistry)

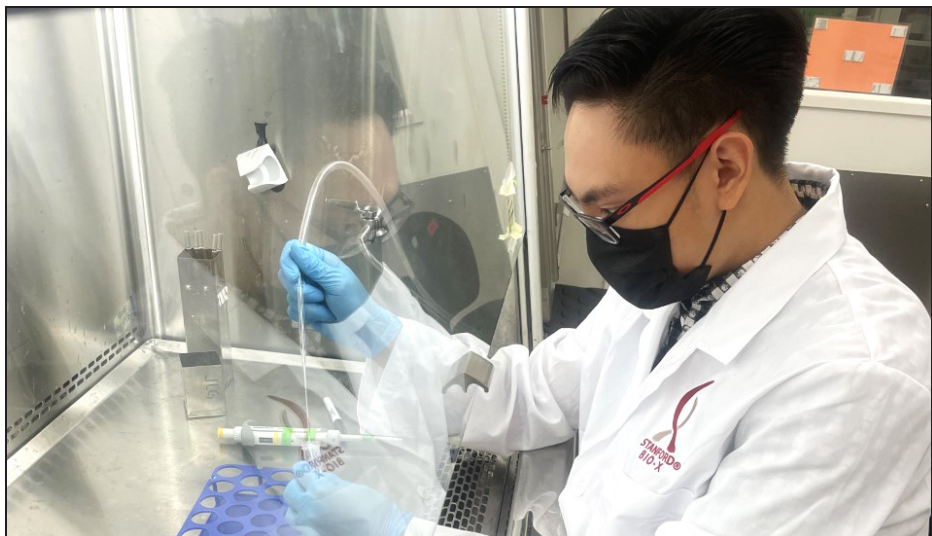
Characterization of a Novel Heat Shock Regulator



YPL225W is a yeast protein of unknown function that has consistently appeared as a candidate modulator of cellular responses to environmental stress (namely heat shock response and heat-induced RNA granule formation). YPL225 has a human equivalent, PBDC1, also of unknown function, and therefore represents a valuable research target. Sebastian's research over the summer will build upon his own prior work attempting to characterize YPL225W and use techniques that include yeast colony transformation, RNA purification, qPCR, flow-cytometry, fluorescence microscopy, and western blotting. All data analysis will employ MATLAB, introducing an interdisciplinary component involving computer science, statistics, and image processing. Data analysis results will help to determine if YPL225W is involved in cellular response to stress.



Sarah Visokay will complete her Stanford Bio-X summer research training with Dr. Allan Reiss



Chris Basco will complete his Stanford Bio-X summer research training with Dr. David Myung

Veronica Alonso, undeclared

Mentor: Juliet Knowles (Neurology & Neurological Sciences and Pediatrics - Operations)

Role of Aberrant Myelin Plasticity in Thalamocortical Hypersynchrony During Absence Seizures

Myelin plays a key role in stabilizing nerve cell signaling. Dr. Knowles's lab discovered that absence seizures induce aberrant activity-dependent formation of myelin (myelination) specific to the thalamocortical seizure network comprised of neurons in both the thalamus and cortex. Further work demonstrated that activity-dependent myelin plasticity in turn promoted seizure progression. The Knowles lab hypothesizes this occurs because aberrant myelination promotes pathological thalamocortical hypersynchrony which leads to seizures. Veronica will assist with this project by manually annotating mouse brain electrical activity (EEGs) collected by the Knowles lab to label ictal (during seizure) and interictal (between seizure) periods and artifacts. She will use the annotated EEGs to measure coherence between inter-hemispheric electrode pairs before and after seizure onset in the mice using customized Matlab software for coherence analysis in the Knowles' lab. Results will improve our understanding of how underlying brain activity-induced myelin restructuring promotes hypersynchrony and seizures.



Isaac Applebaum, Biology

Mentor: Robert Waymouth (Chemistry), Grant M. Rotskoff (Chemistry), and Ronald Levy (Medicine - Oncology)

Designing Improved Polymers for Cell-Type Selective Gene Delivery Using Novel Neural Network Architectures and Non-Convex Optimization Algorithms

With his mentors, Isaac will use flow cytometry of primary immune cells to measure selective mRNA transfection of targeted immune cell types by gene-delivering Charge-Altering Releasable Transporter (CART) polymers, designed by their novel machine-learning algorithms for maximum selectivity. These experiments will complete a paper they aim to publish by the end of the summer on their work using neural networks, non-convex optimization algorithms, and high-throughput data collection to design optimal polymers for various gene-delivery applications. Isaac will run flow cytometry experiments, synthesize polymers, improve their machine learning and optimization algorithms, and help write their manuscript. Their work developing a novel gene delivery method that selectively targets cells could improve the manufacturing of FDA-approved cell-based therapies.



Daniel Arango Sumano, undeclared**Mentor: Michael Snyder (Genetics)****Investigating the Functional Role of Recurrent Repeat Expansions in Prostate Cancer**

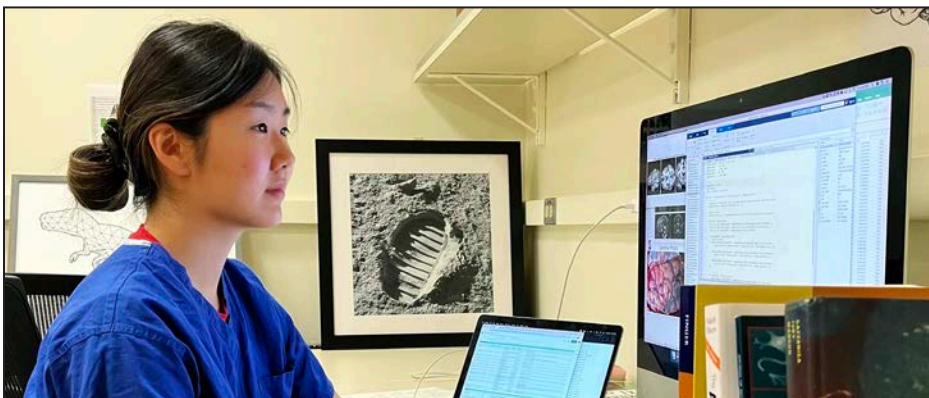
In preliminary research in Professor Snyder's lab, Daniel has identified two recurrent mutations, known as repeat expansions in prostate cancer genomes. To their knowledge, this is the first demonstration of this type of mutation in prostate cancer. Interestingly, one of the two mutations has been found in a cancer-related gene. This summer, Daniel will investigate the functional role of these recurrent repeat expansions and determine whether some of them play a role in cancer development and/or cellular proliferation. He will work with cell culture, use DNA sequencing techniques and protein analysis as part of his investigation into the functional role of repeat expansions in prostate cancer.

Chris Basco, Biology**Mentor: David Myung (Ophthalmology)****Investigating SPACKL and Corneal Healing ex vivo**

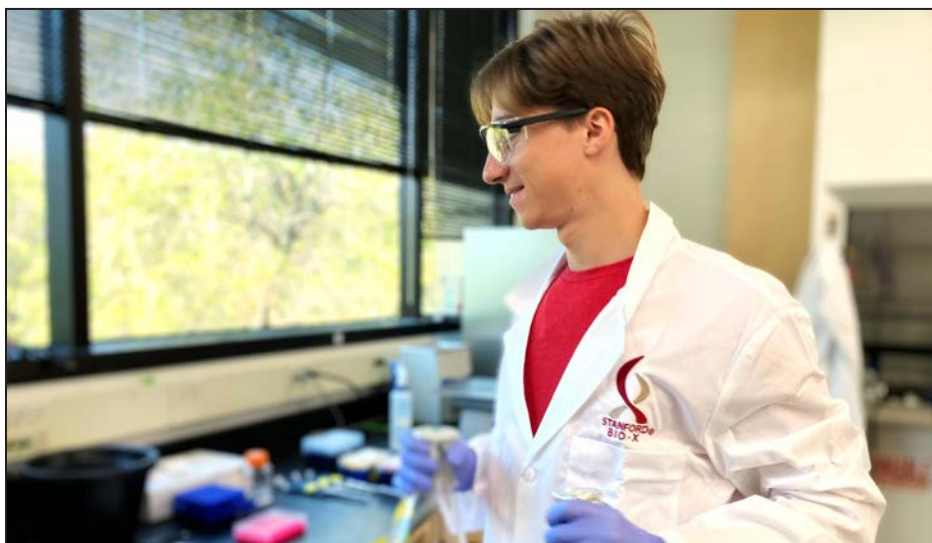
Since 2016, an estimated 12.7 million people worldwide are awaiting corneal transplantation; yet only 1 in 70 patients have access to a sight-saving corneal transplant. Using Sutureless, Photoactivated, Additive Collagen gel Keratoplasty (SPACKL), the Myung lab can stabilize and heal/restore an acutely-injured cornea without requiring invasive transplantation. Their project has two aims: (1) to evaluate SPACKL when sealing corneal defects against commercially-available sealant - by measuring intraocular pressure required to gape treated wounds on pig eye-balls using an infusion pump and manometer and (2) to assess wound healing using a rabbit organ culture model. Their results will provide insight into how effective SPACKL is in treating injured corneas.

Ryan Brennan, Bioengineering**Mentor: Paul Khavari (Dermatology)****Raf-I Cancer Proteomics**

This project looks to study the protein, Raf-I, that plays a direct role in the progression of 30% of cancers. Data from the Khavari lab and others suggest that though Raf-I is necessary for the progression of tumors, it acts through mechanisms that are not completely understood. Preliminary data suggests that Raf-I directly interacts with the enzyme glutaminase (GLS), critical for glutamine metabolism that provides a source of nutrients for cancer cells. The goal of this project is to investigate the mechanism by which Raf-I alters cellular metabolism through interactions with GLS. Ryan will be learning and utilizing molecular and cellular techniques such as microscale thermophoresis, immunofluorescence microscopy, proximity ligation assay, western blotting, co-immunoprecipitation, subcellular fractionation, plasmid cloning, PCR, tissue culture, gel electrophoresis, and proximity dependent biotin identification (BioID). This work will produce data that will help illuminate how the Raf-I protein contributes to the progression of Raf-I-related cancers.



Kristie Park will complete her Stanford Bio-X summer research training with Dr. Josef Parvizi



Matteo Perper will complete his Stanford Bio-X summer research training with Dr. Steven Banik

William Cai, Engineering and Mathematics

Mentor: Kwabena Boahen (Bioengineering and Electrical Engineering)

Expanding the Silicon Brain: Creating a Super-Linear Memory Capacity Network through the Utilization of Spike Sequences in Neuronal Networks

This project aims to improve current computing through a novel approach inspired by neurobiology. Comparisons of the dominant (von Neumann) computing architecture to the human brain reveal the significant differences in the structure, power consumption, and processing capabilities between the two. This led to the quest for neurobiologically-inspired computing architecture: neuromorphic computing. Neuromorphic computing refers to a variety of brain-inspired devices and models that have highly connected synthetic neurons and synapses that can be used to model the activities of neuronal networks. This project aims to improve current neuromorphic computing through a novel approach inspired by neurobiology: utilizing spike sequences (i.e., discrete rather than continuous data) in neuronal networks. The project will first mathematically model the mechanisms of sequence-detecting neuronal networks. Then, the project will use simulation software (e.g., NEST) to generate activities of various sequences of spikes and compute the likelihood of temporally-coincident spike activity. The end goal of this project is to create a super-linear memory capacity network by drawing inspiration from neurobiology.



Ashlyn Callan, Human Biology

Mentor: David Camarillo (Bioengineering)

On-Field Effect of Guardian Cap

Ashlyn will investigate the effect of a commonly used football helmet add-on cover, known as Guardian Cap, that claims to reduce concussion risk. There has been very limited study of its effect, and no on-field data has been analyzed. Ashlyn's goal is to expand testing in lab by using a pneumatic ram to impact a variety of different helmets with and without the Guardian Cap and compare the two conditions. She will use the Camarillo lab's partnership with Stanford football to analyze the head kinematics of players to evaluate the Guardian Cap's effectiveness on field.



“Bio-X was an unparalleled opportunity to dive deep into... research while simultaneously exploring a wide range of other topics through weekly talks given by some of the most innovative researchers in the world.”

—USRP Participant Brandon Bergsneider

Adriana Carter, undeclared

Mentor: Melanie Hayden-Gephart (Neurosurgery)

Modeling Glioblastoma Infiltration and Proliferation Using a Novel Human Brain Organoid System



Glioblastoma (GBM) is a malignant brain tumor with a poor patient prognosis. GBM hijacks and alters the brain immune system to support infiltration in the brain. Our inability to recapitulate the GBM brain immune microenvironment poses a major challenge in effective therapeutic development. Adriana will investigate the employment of air liquid interface (ALI) human brain organoid technology comprised of native brain immune cells. She will study the human GBM infiltration (1) in presence of conditioned media from ALI organoids and (2) when co-cultured with ALI organoids. She hypothesizes that targeting the brain immune cells will reduce GBM infiltration and improve patient outcome.

Grace Chow, undeclared

Mentor: Anthony Oro (Dermatology)

Optimizing Electrospray on Skin Technology for Cell Therapy Delivery



The Oro lab has developed a scalable genetically corrected cell therapy platform for Recessive Dystrophic Epidermolysis Bullosa (RDEB) patients called DEBCT. The platform, however, requires optimization of tissue stem cell delivery using a novel electrospray-on-skin device. Grace's project will correlate DEBCT cell product composition with electrosprayer performance to heal murine skin wounds over two weeks. The Oro lab will use varying human cell compositions of immune pluripotent stem cell (iPS)-derived keratinocytes, fibroblasts and endothelial cells, and measure their wound healing capabilities using a variety of tissue measurement markers. This study will provide the basis for potential future clinical trial studies with DEBCT and the electrosprayer to address RDEB wound healing efficacy.

Ailsa Craven, Biology

Mentor: Karla Kirkegaard (Genetics and Microbiology & Immunology)

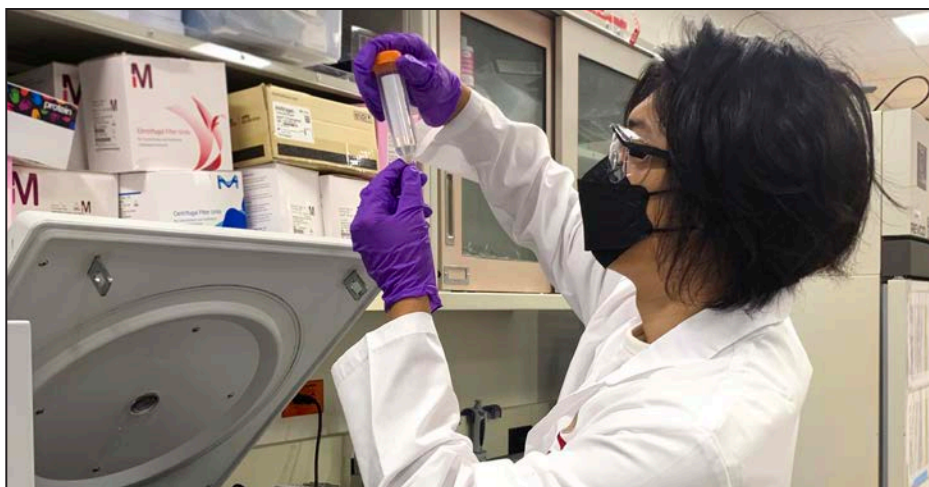
Identification of the Mechanosensing Ion Channel Responsible for Extrusion of Virus-Infected Cells from Colonic Epithelial Organoids



Previous work has found that virus-infected colon cells are removed by whole-cell extrusion, a natural mechanism to eliminate aberrant cells. In a healthy gut, mechanical stresses of cell crowding can trigger extrusion to promote cell turnover. Experiments inhibiting mechano-sensitivity in cells demonstrated that cell extrusion in response to viral infection depends on force-activated mechanosensitive ion channels. In this project, Ailsa will identify the signaling pathway responsible for force-activated mechano-sensitivity using small interfering RNA molecules to inhibit the function of each known-associated gene (Piezo-1, Piezo-2, TRPC1, TRPC6, and TACAN) in organoids and monitor infected cell extrusion using microscopy. This project will aid in discovering the essential genes involved in triggering the physical removal of virally-hijacked cells.



Veronica Alonso will complete her Stanford Bio-X summer research training with Dr. Juliet Knowles



Ryan Suh will complete his Stanford Bio-X summer research training with Dr. Tony Wyss-Coray

Esi Donkor, undeclared

Mentor: Ravindra Majeti (Medicine - Hematology)

Influence of External Stressors on the Behavior of Pre-Leukemic Hematopoietic Stem Cells



The Majeti lab aims to investigate how inflammatory stressors alter the behavior of pre-leukemic stem cells. They will use CRISPR/Cas9 to modify healthy primary human hematopoietic stem cells (HSCs) to carry pre-leukemic mutations, and subject them to inflammatory stimuli including lipopolysaccharide, polyI:C and Interferon-gamma. Following stimulation, they will assess cell cycling, cell fate decisions, differentiation, and colony formation. Next, they will determine the migratory behavior of mutant versus normal cells using a time-lapse live cell imaging system. Finally, they will perform transcriptome sequencing to determine gene expression patterns driven by these external stressors. Together, they anticipate delineating how these stimuli contribute to inflammation-driven expansion of mutant cells into leukemia.

Asher Fanous, Anthropology

Mentor: Shirat Einav (Medicine - Infectious Diseases and Microbiology & Immunology)

High Resolution Study of COVID-19 Pathogenesis in Unique Human Lung Organoids



The mechanisms that govern differential COVID-19 outcome across genders, age, ethnicities, etc. are unknown. This project's goal is to capture variation in the host response to SARS-CoV-2 in a unique human adult lung organoid (ALOs) model. The Einav lab will conduct a longitudinal study of SARS-CoV-2 infection in ALOs derived from several donors via virus-inclusive single cell RNA-sequencing. They will define the target cells of SARS-CoV-2 and monitor variation in gene expression between infected, bystander, and uninfected cells. To identify candidate host targets for therapy, they will identify genes whose expression is upregulated in correlation with viral RNA. This experiment will provide further potential therapeutic targets for addressing SARS-CoV-2 infections.

“My summer research with Bio-X helped solidify my interests in neuroscience and cancer biology and made me want to be more involved in research, as I hope to enter medical school post-graduation... Since the summer experience, I have gotten another opportunity to pursue funded research, building off the skills that I learned from the Bio-X Undergraduate Summer Research Program. I am excited to see these skills grow as I build my own scientific confidence!”

—USRP Participant Bryanna Godfrey



Ashlyn Callan will complete her Stanford Bio-X summer research training with Dr. David Camarillo

Lexi Golden, Human Biology

Mentor: Natalia Gomez-Ospina (Pediatrics - Medical Genetics and Pediatrics - Stem Cell Transplantation)

Role of Galactocerebrosidase Gene Knock-Out in Human Cord-Blood Derived Hematopoietic Stem Cell Proliferation and Differentiation

Galactocerebrosidase (GALCase) enzyme deficiency results in a lethal neurodegenerative disorder known as Krabbe disease. While its role in cerebral homeostasis (sphingolipid breakdown and maintenance of normal brain myelination) is clearly established, the Gomez-Ospina lab posits that GALCase is also important in hematopoietic stem cell (HSC) production and development. To examine this, Lexi will use CRISPR/Cas9 to remove GALCase from human cord-blood derived HSCs and comprehensively assess their production and development potential in the lab. The project involves cell engineering, quantification of genome editing outcomes of the GALCase gene, biochemical assays of enzyme activity and metabolite accumulation, as well proliferation and colony formation assays. Experimental results will contribute to our understanding of how GALCase is involved in blood-related stem cell production and development.



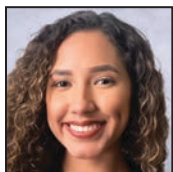
Doran Goldman, Biology

Mentor: David Relman (Medicine - Infectious Diseases and Microbiology & Immunology)

Understanding Strain Colonization Using Gut-Derived Microbial Communities

The human gut microbiome remains remarkably diverse and stable over the course of adult life, despite constant exposure to new microbes from the environment. To understand the ecological processes that help maintain this diversity and resilience to invasions, Doran will use a collection of previously isolated gut microbes to construct a set of distinct, naturalistic communities in the lab. He will use ribosomal gene sequencing to assess bacterial species composition as strains are introduced to communities and understand how ecological factors such as metabolic diversity, resource availability, and interactions between species help determine which species successfully colonize and become part of the community. Exploring ecological dynamics and relationships among human gut microbes is essential for understanding human health.



Gisselle Gonzalez-Perez, undeclared**Mentor: Yang Sun (Ophthalmology)****Investigating the Connection Between Glaucoma and Primary Cilia**

Glaucoma is the second leading cause of blindness worldwide, however, there is no cure and limited treatments. Glaucoma results from the death of retinal ganglion cells (RGCs), which have cilia, antenna-like organelles that project from the cell surface and act as a hub for cellular signaling pathways. Defects in cilia localized protein (OCRL) are known to cause a rare disease known as Lowe syndrome in which many patients develop glaucoma. Gisselle proposes to use a compensatory protein to rescue OCRL deficit in a retinal model derived from Lowe patient-stem cells (iPSCs). This work will investigate the efficacy of reducing the development of glaucoma using the compensatory protein.

Kaitlin Harold, Computer Science**Mentor: Alison Marsden (Pediatrics - Cardiology and Bioengineering)****Flow Simulations on Patient-Specific Cardiac Geometries to Inform Biventricular Reconstruction Surgeries**

The goal is to improve success of reconstruction surgeries using computational models of patient hearts. First, the Marsden lab will identify design parameters of the surgery, such as geometry and location of interventions, and measures of success (such as maximizing oxygen saturation). Then, using MRI data from the patients of Dr. Michael Ma, they will build a computational model of pre-surgical hearts in the software SimVascular before modifying them to replicate the surgical procedure and create a post-surgical model of the heart. They will then use these post-surgical models to run simulations with varied surgical parameters to determine which are most successful. This work will provide insight into identifying aspects of surgery that can be modified to improve heart reconstruction.

De'Angelo Hermesky, Biology**Mentor: Birgitt Schuele (Pathology)****Functional Characterization and Treatment of ATXN10 Cell Lines**

Spinocerebellar Ataxias (SCAs) are inherited progressive disorders which can lead to impaired coordination, and slurred speech. There are over 40 different SCA subtypes, with onset ranging the entire lifespan. Given the variation in nature, treatment options are scarce, however a promising research avenue is using small molecules that selectively target mutations known as repeat expansions present in many SCA subtypes. The goal of this project is to exploit a penta-nucleotide repeat, 'ATTCT', found in SCA subtype 10. In collaboration with Dr. Matthew Disney, using the compound (2AU-2) that selectively binds base pairs 'AU', to inhibit RNA, the Schuele lab will test to what extent they can ameliorate dysfunctional cell types developed from induced-pluripotent stem cell (iPSC) neurons, fibroblasts, and possibly Purkinje cell lines. This work will allow them to assess the efficacy of 2AU-2 as a treatment for SCAs.



Om Jahagirdar will complete his Stanford Bio-X summer research training with Dr. Hunter Fraser

Clarisse Hokia, Computer Science

Mentor: Paul Wang (Medicine - Cardiovascular Medicine)

Developing a Delivery System for the Positioning of a High Frequency Ultrasound Ablation System



Treatments for irregular heartbeat (arrhythmias) are currently invasive or partially effective. As a subproject of the Wang Lab's high frequency ultrasound (HIFU) ablation system project that aims to correct arrhythmias, Clarisse will work on the development of a delivery system for the positioning of a HIFU system. By the end of the summer, a prototype will be developed following the engineering design process and tested using modeling software and a pre-developed testing apparatus. She will also assist in studies and the development of a bench test apparatus to test the efficacy of the prototype ablation arrays. The Wang lab hopes to improve upon the novel ablation system for the treatment of arrhythmias and a non-invasive delivery of the system.

Edward Huang, Computer Science

Mentor: Jonathan Payne (Geological Sciences)

Identifying Biotic Factors Influencing Marine Animal Body Size Trends During the Phanerozoic Eon



The average body mass of marine animals increased by a factor of >150 during the last 541 million years (Phanerozoic Eon). Because body size scales with important organismal traits such as ecology, physiology, and anatomy, it is uncertain which trait(s) influenced this extreme increase in body size. Edward plans on collecting body size data from fossils both in the lab and from published literature. He will also use these data and information from modern animal analogs to estimate two physiological traits, respiratory rates and metabolic demand, for these fossils. Statistical analyses will then be conducted to determine which organismal traits can best explain average body size increase and aid in future modeling of marine system dynamics.

Winnie Huang, Chemical Engineering

Mentor: Danielle Mai (Chemical Engineering)

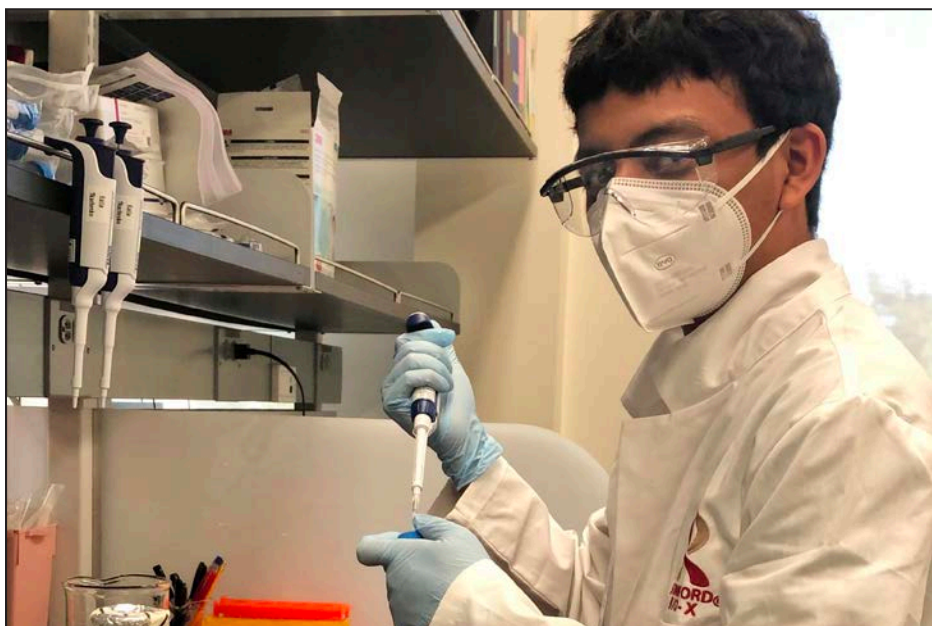
Structural Insights into Calcium Responsive Polypeptides



Calcium is an intracellular messenger that regulates key cellular functions. This project aims to characterize the folding dynamics and structure of repetitive proteins that fold and unfold in response to the presence of calcium. Winnie will generate these calcium responsive proteins using Mai Lab facilities. Subsequently, high-throughput preparation of protein crystals will be conducted in collaboration with the Wakatsuki lab using a hanging drop crystallization robot. X-ray crystallography using SLAC facilities will provide high-resolution structures of the folded proteins. These findings will then be applied to characterize the folding dynamics and crystal structures of fusion proteins that include this repetitive domain. Concurrent with the expression and purification of calcium responsive proteins exists an investigation into how protein folding kinetics is influenced by protein sequence and ion concentration. This work will contribute to studying protein structure, conformation, and function in response to calcium.



Sydney Nagy will complete her Stanford Bio-X summer research training with Dr. Michelle James



Daniel Arango Sumano will complete his Stanford Bio-X summer research training with Dr. Michael Snyder

Amisha Iyer, Biology

Mentor: Rajat Rohatgi (Biochemistry and Medicine - Oncology)

Understanding the Biochemistry Behind Human Mutations in Evc2

The Hedgehog signaling pathway is essential for vertebrate embryonic development. The Evc2 protein is a key player in Hedgehog signaling, and human mutations in Evc2 cause skeletal birth defects. Evc2 protein contains a sequence of 43 amino acids called the Weyers peptide which is a hot spot for disease-causing mutations. In Amisha's project, she will study the function of the Weyers peptide by generating known mutations and then determining how they inhibit Hedgehog signaling. This would contribute to our understanding of the Evc2 protein, whose mechanistic role in Hedgehog signaling critical for embryonic development remains unknown.



Emma Jaeger, Biology

Mentor: Ian Gotlib (Psychology)

Examining the Impact of Early Life Stress on Adolescent Brain Structure and Inflammation

Early life stress (ELS) is associated with significant negative outcomes, including high rates of psychopathology in adolescence. To better understand the effects of ELS on adolescent psychological functioning, it is important to elucidate biological mechanisms that shape brain structure. One such mechanism is altered immune function, specifically inflammation. Further, different kinds of stressors may differentially affect neuroimmune associations. Emma plans to examine how various types of ELS affect the association between inflammation and brain structure in adolescents. Emma will use an immune signaling protein (blood cytokine) levels to measure inflammation, structural MRI to assess gray matter volume, and clinical interviews to assess ELS. This work will explore the associations between stress and neuroimmunity.



"My participation in Bio-X has both ignited and fueled my interest in interdisciplinary studies. This program has provided me not only with just fundamental experiences in the lab, but also with a community that has supported my curiosity spanning across the fields of physics, developmental biology, oncology, and biomedical research."

—USRP Participant Anaïs Tsai

Om Jahagirdar, Engineering**Mentor: Hunter Fraser (Biology)****Identifying Novel Instances of Cultural-Genetic Coevolution**

Cultural-genetic coevolution refers to the development of local cultural practices alongside local genetic adaptations to diverse diets, pathogens, altitudes, temperatures, and other environmental factors. Utilizing sequencing data from 120 publications, novel methods for assessing genomic variation, and the Ethnographic Atlas, Om has developed a high-resolution genetic-cultural global database including 6,375 unique individuals. Om will further develop a computational workflow to identify instances and trends of cultural-genetic coevolution utilizing a statistical framework. Gained insights will help paint a more complete picture of human evolution, understand the drivers of population phenotypic diversity, and compensate for Eurocentric data-driven practices in today's globalized world.

Charu Jain, Art Practice**Mentor: Yunzhi Peter Yang (Orthopaedic Surgery)****Testing Human Mesenchymal Cell Viability using Encapsulation within Hydrogels**

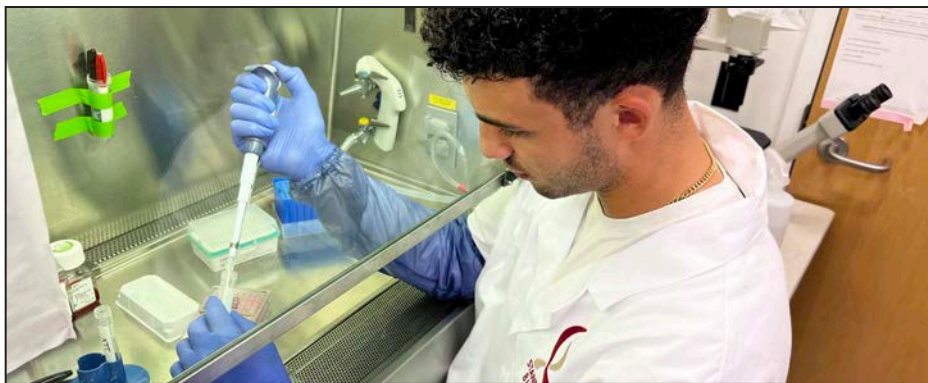
As a whole, the Yang lab is working on creating synthetic tissue scaffolds that can be inserted into areas of necrotic tissue to promote cell production and tissue regeneration. In order to test cell viability under such conditions, Charu has been conducting a series of experiments that examine different parameters. She has encapsulated human stem cells into synthetic tissue, which she made from gelatin and other materials. She has tested parameters such as varying concentrations of the gelatin, exposure time under light, and cell density, later testing viability. She will also be working with other tissue types and compounds (PCL/TCP/Gelatin) to test solubility and conductivity to promote proliferation of bone cells known as osteoblasts. These experiments will help determine how to improve the efficacy of synthetic tissue scaffolding for tissue regeneration.

Isaac Kandil, undeclared**Mentor: William Giardino (Psychiatry & Behavioral Sciences)****Examination of Sex Differences in Bed Nuclei of the Stria Terminalis (BNST) Neural Circuit Activation Patterns**

The Giardino Lab focuses on the neurobiology of stress, addiction, and sleep/wake disturbances. They are using mice as the animal model to study the mechanisms by which emotional brain circuits drive behavioral responses to stressful and rewarding experiences. The lab has initiated examinations of a brain region within the extended amygdala called the bed nucleus of stria terminalis (BNST) which is known to receive inputs from sex steroid hormones and control stress-related behaviors. Within the BNST, one neuronal cell subpopulation is marked by the production of the protein cholecystokinin (CCK). Using anatomical and cell staining methods, Isaac's project will describe differences in the expression patterns and behavioral impacts of CCK-BNST neurons between female and male mice, essentially exploring behavioral differences between female and male biology.



Katy Werwath will complete her Stanford Bio-X summer research training with Dr. Laramie Duncan



Harrison Konsker will complete his Stanford Bio-X summer research training with Dr. Joseph Shrager

Audrey Kim, undeclared

Mentor: Nathanael Gray (Chemical & Systems Biology)

Identifying and Developing Covalent E3 Ligase Ligands for the Development of Proteolysis Targeting Chimeras (PROTACs)

Proteolysis targeting chimeras (PROTACs) are small molecules that allow for selective degradation of target proteins via recruitment of an E3 ubiquitin ligase. While PROTACs have garnered attention due to the potential to downregulate disease-causing proteins, including “undruggable” targets, the lack of available E3 ligase binding ligands is a major bottleneck in designing PROTACs. In order to address this problem, Audrey’s work will focus on identifying and characterizing covalent ligands that target E3 ligases to expand the pool of available E3 ligases for developing PROTACs. She will carry out cellular biology techniques (i.e., immunoblotting, tissue culture) to test the synthesized molecules’ effects to engage the target E3 ligase(s) and induce degradation of target protein(s) in cells. This work is all done with the overarching goal of finding more effective ways to treat diseases.



Jaeah Kim, undeclared

Mentor: Karl Deisseroth (Bioengineering and Psychiatry & Behavioral Sci.)

Identifying the Role of Aberrant Neural Activity in Alzheimer’s Disease

While it is known that neural systems fail and cognition declines during the progression of Alzheimer’s Disease, the underlying neuronal mechanisms remain unknown. This project aims to understand how changes in single cell neuronal activity and their associated networks in Alzheimer’s disease directly influence behavior. To begin answering this question, neural activity over disease progression will be studied through fluorescence imaging of the dorsal hippocampal CA1 region of the brain during learning and memory tasks in Alzheimer’s mice models. Understanding the link between neural activity and cognitive decline will contribute to an updated understanding of Alzheimer’s Disease and more refined approaches towards therapeutic trials.



Jordan Kimia, Biology

Mentor: Daniel Jarosz (Chemical & Systems Biology and Developmental Biology)

Role of ER-Mitochondria Contact Sites in Proteostasis

Jordan will work with mentors on modeling the biological mechanisms of protein maintenance at the Endoplasmic Reticulum (ER)-mitochondria contact sites. They will do experiments on the Baker’s yeast model organism to uncover potential mechanisms of regulating protein stress. They will use proximity labeling enzymes and mass spectrometry to assess the protein composition at the contact sites with and without stress to identify which proteins become active or inactive under stress conditions. In parallel, they will run experiments to identify the activity at the contact sites under various models of stress. They will pool their data from these experiments to delineate which of several potential models are valid and identify key next steps in their pursuit to understand how protein structure and function are maintained under stress.





Ashley Nies will complete her Stanford Bio-X summer research training with Dr. Jeffrey Goldberg

Harrison Konsker, undeclared

Mentor: Joseph Shrager (Cardiothoracic Surgery)

A Retrospective Study on Current Treatments and a Novel CRISPR/Cas9-Based Gene Therapy for EGFR-mutated (Exon19) Lung Cancer

In 2021, around 130,000 Americans died from lung cancer. Current treatments for lung cancer often lead to drug resistance and cancer recurrence. Harrison will employ a new approach, utilizing the CRISPR/Cas9 genome-editing tool to destroy and repair mutations in the epidermal growth factor receptor (EGFR) gene which drives uncontrollable cancer cell growth. Using single guide RNAs alone or in combination with single stranded DNA template to transfect a PC9/Cas9 stable cell line, the mutated EGFR gene will either be destroyed by random mutations (insertions and/or deletions) or repaired by homologous DNA replacement. Afterwards, he will examine the growth, metabolism, and the underlying mechanisms of the treated cancer cells. This experiment will allow us to describe the different outcomes in cancer treatment between destruction of mutated EGFR versus replacement with a healthy version of the gene.

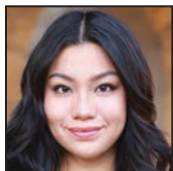


Melody Ly, Human Biology

Mentor: Jill Helms (Surgery - Plastic & Reconstructive Surgery)

Shaping the Face: The Reconstruction of Congenital Anomalies and the Influence of Age on Surgical Outcome

Melody's project aims to discover the relationship between age at which surgical reconstruction of cleft palate is performed, and the impact on subsequent facial growth. A mouse model of surgical scarring of the hard palate will be used. An oral surgeon will perform surgeries, and she will assist. Facial growth will be assessed using micro CT imaging at various time points after surgery. Once facial growth arrest is demonstrated, tissues will be harvested and analyzed using histology and immunohistochemistry to understand how growth is arrested. Exploration of the relationship between patient age and subsequent facial growth will aid in determining optimal age for treatment.



Abigail Maemoto, undeclared

Mentor: Albert Wu (Ophthalmology)

Generating an Eye Interspecies Chimera with Blastocyst Complementation

Blastocyst (early-stage embryo) complementation is a technique used to create chimeras (organisms containing cells originating from 2 different fertilized cells) by implanting donor stem cells into a host embryo. Abigail aims to create the first eye interspecies chimera through removal via CRISPR and complementation with rat embryonic stem cells (rESCs). Healthy mouse embryos will be isolated and electroporated with guide-RNAs and Cas9 to remove genes essential for eye development (anophthalmia). Embryos will be allowed to develop to the blastocyst stage where rESCs will be injected to complement the deficient niche. The Wu lab hypothesizes that the anophthalmic mouse will develop rat eyes with rESC complementation. This work will determine if removal of genes responsible for eye development via CRISPR and blastocyst complementation with rat homologs is possible.



Karla Manzanares, Bioengineering**Mentor: Calvin Kuo (Medicine - Hematology)****High-Throughput Phenotyping of Endometrial Organoids**

The endometrium is the inner lining of the uterus that regenerates and degrades over the course of each menstrual cycle in preparation for pregnancy. Currently, little is known about the characteristics of uterine endometrial stem and progenitor cells. This information is vital for understanding the cyclical, dynamic regenerative capacity of the endometrium and the origins of endometrial cancers. This project will investigate this question by growing and then isolating endometrial organoids from microwells for high throughput characterization and time-lapse imaging. Molecular and cellular differences can then be described between two morphologically distinct types of endometrial epithelial organoids: cuboidal and columnar endometrial organoids. Additionally, this microwell approach will provide a method for isolating distinct morphologies of genetically engineered endometrial organoids, which are designed to model cancer. This work will provide a means for correlating morphological features with molecular profiles, and allow us to better understand and improve our understanding of endometrial cancers.

**Jodie Meng, Engineering****Mentor: Kara Davis (Pediatrics - Hematology & Oncology)****Investigating Mechanisms of Antigen Loss from CAR T-cell Therapy**

Chimeric antigen receptor (CAR)-T cell immunotherapy has revolutionized the treatment of childhood leukemia by reprogramming T-lymphocytes to terminate antigen-expressing cancer cells. However, a significant subset of patients relapse following therapy due to antigen loss. Jodie's project aims to describe how the expression of developmental proteins can alter leukemia-cell characteristics. To do so, she is performing reductions of gene expression on leukemia cell lines and quantifying changes over time through mass cytometry and single-cell RNA sequencing. Following data collection and analysis, she will work with the lab to develop predictive models of patient responses to CAR-T cell therapy, providing a better understanding of how leukemia cells adapt to treatment over time.



Marc Soong will complete his Stanford Bio-X summer research training with Dr. Lauren O'Connell

Briana Martin-Villa, Bioengineering

Mentor: Sarah Heilshorn (Materials Science & Engineering)

Biomaterials to Improve Intestinal Organoid Culture



Hyaluronic acid (HA) is a prominent component of the native intestinal matrix that is implicated in intestinal stem cell production. Thus, Briana seeks to explore its impact on intestinal organoid stem cell populations grown within an engineered matrix that includes HA. She hypothesizes that intestinal stem cells will become enriched over time in organoids grown in HA-containing matrices compared to those grown in the current standard (Matrigel) or control matrices that lack HA. To test this hypothesis, she will culture mouse and human organoids, with and without inhibitors of HA signaling, and characterize morphology, gene expression, and protein expression; showcasing the importance of HA in growing intestinal stem-cell derived organoids.

Georgios Mikos, undeclared

Mentor: Fan Yang (Orthopaedic Surgery and Bioengineering)

Harnessing Sliding Hydrogels to Elucidate How Mobility Modulates Mechanosensing and Stem Cell Differentiation in 3D



Mesenchymal stem cell (MSC) development into connective tissue, blood vessels, and lymphatic tissue strongly depends on the microenvironment of the cells. When encapsulated in physically crosslinked hydrogels, MSCs exhibit stiffness-dependent differentiation with increasing stiffness promoting osteogenesis (or brittle bone disease). However, in covalently crosslinked hydrogels, osteogenesis was minimized regardless of stiffness. Given that the key difference between covalently and physically crosslinked hydrogels is the absence or presence of molecular mobility, Georgios hypothesizes that mobility regulates how MSCs sense matrix stiffness (i.e., mechanosensing) and differentiation. He will harness sliding hydrogels, a tool invented by the Yang lab, to elucidate how mobility modulates stem cell stiffness mechanosensing and differentiation in 3D and identify the underlying molecular mechanisms. This work will contribute to our understanding of how cellular microenvironments influence mesenchymal stem cell development and related disease.

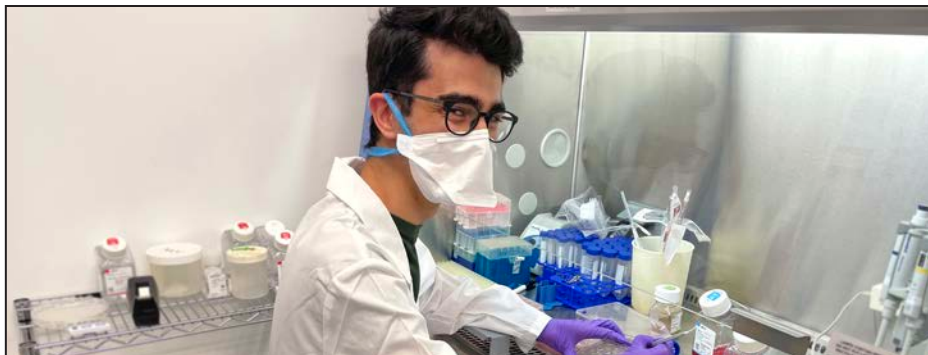
Allegra Minor, Engineering

Mentor: Laura Attardi (Radiation Oncology - Radiation & Cancer Biology)
Using Single Cell Methods to Understand How p53 Loss Promotes

Pancreatic Ductal Adenocarcinoma Progression



Pancreatic ductal adenocarcinoma (PDAC) is the 3rd deadliest cancer in the US - projected to be the 2nd by 2026. While functionally impactful mutations of the protein p53 tumor suppressor is observed in ~75% of PDACs, how p53 inactivation promotes progression from epithelial cells to PDAC is not well understood. In this project, Allegra will conduct single-cell sequencing assays for transposase-accessible chromatin (scATAC-seq) in genetically engineered mouse models of early and late PDAC progression with and without p53. She will combine this scATAC-seq data with scRNA-seq data from the Attardi lab to correlate differential genome-wide regulatory landscapes and gene expression to understand how loss of p53 promotes PDAC.



Georgios Mikos will complete his Stanford Bio-X summer research training with Dr. Fan Yang



Gisselle Gonzalez-Perez will complete her Stanford Bio-X summer research training with Dr. Yang Sun

Nathan Mohit, undeclared

Mentor: Alan Cheng (Otolaryngology - Head & Neck Surgery)

Molecular Architecture of Bundles in Surviving and Regenerating Hair Cells in the Adult Mouse Utricle After Damage



This project aims to characterize the molecular constituents of hair bundles on surviving and regenerating hair cells in the mouse inner ear utricle. Nathan will assess transgenic mice overexpressing the hair cell reprogramming proteins (Atoh1, Gfi1 and Pou4f3) following cell damage. He will perform drug injections in mice, microdissections of utricles, immunostaining and imaging of tissues at different timepoints and genetically characterize both surviving and regenerating hair cell colonies. He will analyze images using Imaris, Fiji and Prism software to create a cohesive report of the study's findings. Results will help us to understand the local, temporal and molecular differences between surviving and regenerating inner ear hair cells following injury.

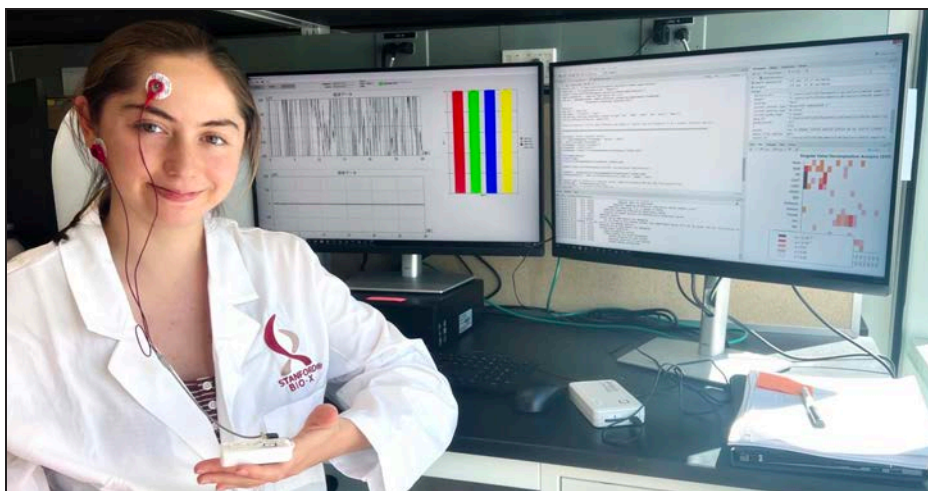
Sydney Nagy, Human Biology

Mentor: Michelle James (Radiology and Neurology & Neurological Sci.)

A Novel Translational Strategy for Detecting Maladaptive Inflammation in Alzheimer's Disease



Dr. James's research is dedicated to the development of neuroimmune molecular imaging strategies. Sydney's project will investigate the sensitivity, specificity, and overall utility of a novel positron emission tomography (PET) imaging biological marker of the aberrant activation of immune cells located in the central nervous system in the context of Alzheimer's disease (AD). Specifically, she will use PET/CT imaging and complementary immune profiling techniques (e.g., histology, flow cytometry) to non-invasively assess neuroinflammation with disease progression in rodent models of AD. She will assist in conducting the imaging studies as well as the subsequent histological and immunological experiments, learning a host of skills including molecular imaging, PET image analysis, and immunohistochemistry. This work will allow them to explore the molecular landscape of AD as neuroinflammation occurs.



Sofia Vera Verduzco will complete her Stanford Bio-X summer research training with Dr. Gen Shinozaki

Nina Nguyen, undeclared

Mentor: Vittorio Sebastiano (Obstetrics & Gynecology - Reproductive Biology)

Prevention or Reversal of CAR T Cell Exhaustion Using Lentiviral Delivery System

Chimeric antigen receptor T cells (CAR T) are immune cells that have been genetically engineered to produce an artificial T cell receptor for use in immunotherapy, for example in cancer therapies. However, CAR T cells experience a state of exhaustion in which their efficiency and effectiveness decrease as they age. Nina is working to see how the overexpression of the Yamanaka factors (Oct3/4, Sox2, Klf4, c-Myc) can either reverse or prevent CAR T exhaustion. Yamanaka factors are used to induce a state of pluripotency in cells that have already differentiated into specific cell types and have lost their pluripotent developmental potential, essentially reversing biological age. The Yamanaka factors will be delivered into cells using a lentiviral vector Tet-On inducible system. The Tet-On system allows for control over gene expression activation by doxycycline, which can be used to assess gene function. Throughout this long-term project Nina will be learning how to perform various lab techniques including PCR, cloning, transfection, western blot, microscopy, tissue culture, ChIP-sequencing, transformation, and more to help create a new lentiviral system for delivering Yamanaka factors into CAR T cells and to understand how Yamanaka factors impact CAR T cell function.



Ashley Nies, Human Biology and Political Science

Mentor: Jeffrey Goldberg (Ophthalmology)

Optimization of Adeno-Associated Virus to Porcine Retinal Ganglion Cells and Serum Neutralizing Antibody Response

Traumatic optic nerve injury may lead to loss of vision with the death of retinal ganglion cells (RGCs), the neurons that transmit visual information from the eyes to the brain. RGCs are highly sensitive to injury, and like other neurons in the central nervous system, they cannot regenerate. Thus, injury may result in permanent blindness. While advancements in neuroprotection and regeneration have been made in rodent models, limited data in large animal models remains a challenge for developing human therapies. Ciliary neurotrophic factor (CNTF) and cyclic AMP (cAMP) promote RGC survival and regeneration in rodent models, and Ashley plans to research their role in a porcine model. This will include inducing a porcine model of optic nerve injury, administering CNTF and cAMP intravitreally, quantifying RGCs, and comparing these values to the vehicle control. This study will provide insight into the extent to which rodent treatments are translatable to larger species and whether CNTF and cAMP may be a viable therapeutic candidate in humans.



Katelyn Osuna, Psychology**Mentor: Jason Yeatman (Pediatrics, Education, and Psychology)****Investigating the Relationship Between Visual Attention and Eye Movements - A Natural Reading Behavior Study**

Reading is a complex task demanding the shifting and focusing of attention. Reading development, visual attention development, and precision in eye movement patterns are all tightly intertwined. The Yeatman lab and Katelyn hypothesize that certain metrics of eye movements – like saccadic velocity (the time taken to move between words), reading speed, fixation duration (how long one lingers on a word) – correlate with voluntary control of attention. To test this, they will correlate measures of eye movement in natural reading with their performance in a visual encoding task, testing their ability to recognize letters and letter positions with voluntary and involuntary attentional cues. This work will improve our understanding of the relationship between visual acuity and the ability to focus.

Kristie Park, Sociology**Mentor: Josef Parvizi (Neurology & Neurological Sciences)****Neural Mechanisms of Social Attribution from Faces**

This project aims to identify the neural mechanisms underlying the social attributions people draw upon perceiving faces. Initially, Kristie will design concise and explicit cues for both extremes of each social trait dimension: warm, competent, feminine, youthful, trustworthy, dominant, and attractive. Data will be collected using a combination of fast temporal resolution single-neuron and intercranial Electroencephalography (iEEG) recordings, electrical stimulation, and pre-surgical resting-state and localizer functional (f) MRI in the same patients. She will be working specifically on the Social Context Task where patients are first provided with a “social context” cue according to the seven social trait dimensions. Her primary tasks will be to write and record these cues, assist in working with patients to collect the iEEG and fMRI recordings, and analyze the data using MATLAB. She will work to identify and analyze the differential neurological responses with and without social contextual manipulations to pinpoint a neural account of social attributions from faces and contextualizing these results with what explicit and implicit biases may influence patients’ neural activity.



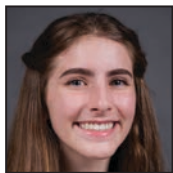
Isaac Applebaum will complete his Stanford Bio-X summer research training with Dr. Robert Waymouth, Dr. Grant Rotskoff, and Dr. Ronald Levy

Matteo Perper, Chemistry and Italian**Mentor: Steven Banik (Chemistry)****Development of PLA2 Enzymes as Endosomal Escape Therapeutic Agents**

Methods of delivering large biomolecular cargo to the intracellular space (cytoplasm) are limited, preventing successful use of protein drugs to modulate intracellular pathways. Therefore, a better delivery strategy could be revolutionary in targeting previously “undruggable” space and address unmet medical needs. It is particularly difficult to deliver drugs to the cytoplasm because of the lack in key knowledge about the underlying biology of endosomes (membrane-bound vesicles). The mechanisms by which a molecule can escape an endosome or how those endosomes are subsequently repaired are poorly understood. Matteo hopes to better understand enzymatically mediated endosomal escape. He will design, clone, express, and purify phospholipase A2 (PLA2) enzymes used by bacteria to cleave endosomal lipids and enhance intracellular delivery. He will run the purified enzymes in biochemical and cell-based assays - using TEV protease-activated green fluorescent protein (GFP) expressing cells - to detect if they enter the cytosol. To further assess cytosolic penetration, he will use flow cytometry and collect relative GFP turn-on data. He will analyze cytotoxicity and cell lysis to determine the viability of a PLA2 therapeutic delivery strategy. Finally, he will mutagenize PLA2s to investigate the biological mechanism of cell entry. The mechanisms by which a molecule can escape an endosome or how those endosomes are subsequently repaired are not understood. By taking an example from nature, the Banik lab hopes to characterize endosomal escape and develop a tool for mechanistic studies.

**Rebecca Pizzitola, Symbolic Systems****Mentor: Laura Prolo (Neurosurgery)****Longitudinal Assessment of Healthcare Charges in the Treatment of Pediatric Hydrocephalus**

Hydrocephalus, fluid build-up in the brain, is one of the most common conditions treated by pediatric neurosurgeons and is treated with either an endoscopic third ventriculostomy (ETV) or insertion of a ventriculoperitoneal shunt (VPS). Long-term costs for these surgical procedures are not well studied and rising healthcare costs are a significant concern for families and society. Using a large healthcare database, the Prolo lab will examine the longitudinal costs of treating hydrocephalus with a VPS or ETV. Rebecca will classify expenditures from ~900 patients into inpatient, outpatient, and auxiliary, and conduct statistical analyses to determine what demographic and clinical factors drive expenditures by treatment group over 10 years. This work will further our understanding of how the two treatments impact patients differently long-term.

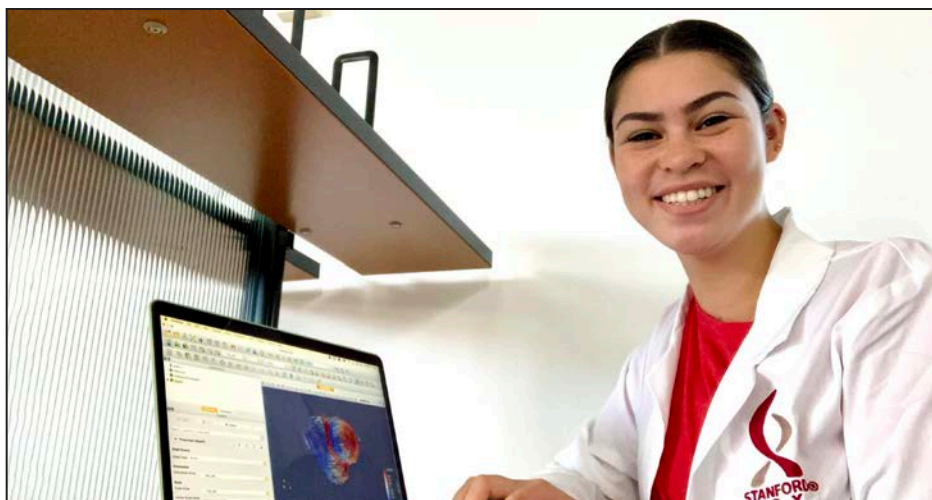
**Julia Ransom, undeclared****Mentor: Erin Gibson (Psychiatry & Behavioral Sciences)****Determining the Role of Circadian Transcriptional Control in Myelin-Forming Precursors**

There remains a significant gap in our knowledge of how the circadian (24-hour biological cycling) system regulates oligodendrocyte precursor cells (OPCs) that play a key role in the central nervous system and myelination in health or putative dysmyelination in brain disorders. Julia will study how the identified principal circadian regulator protein BMAL1 controls OPCs function. Using genetic knockdown strategies, immunofluorescence and RNA-sequencing, she will evaluate the role of the circadian clock in OPCs and assess the effect of its dysregulation. Understanding how the circadian clock regulates myelin-forming precursors will impart unique insights into normal and aberrant brain development and provide a foundation to investigate how molecular mechanisms affect neurological development and disorders.



“The Bio-X Undergraduate Research Fellowship [allowed] me to focus on my research in a meaningful way all summer. The invaluable funding, support, and weekly talks reaffirmed and strengthened my interest in pursuing a career in research. It is such a great honor to have participated in this program.”

—USRP Participant Persiana Saffari



Kaitlin Harold will complete her Stanford Bio-X summer research training with Dr. Alison Marsden

Shriya Reddy, undeclared

Mentor: Euan Ashley (Medicine - Cardiovascular Medicine, Genetics, and Biomedical Data Science)

Development of a Polygenic Risk Score of the Left Ventricular End Diastolic Volume and Mass Using a Deep Learning Approach

An accurate understanding of how the genome contributes to observable characteristics is becoming crucial for personalized therapy in cardiovascular medicine. Cardiomyopathies are known to have a strong genetic background. Shriya's project aims to develop a polygenic risk score of left ventricular end diastolic volume and mass, using Magnetic Resonance images and whole-genome sequencing data from the UK Biobank. Firstly, a machine learning model will be trained to automatically label the MRI dataset. Secondly, the obtained volume and mass data will be used for the genome-wide association (GWA) study, using a machine learning model. Lastly, a polygenic risk score will be developed using Stanford University patient data. Cardiomyopathy risk prediction, contingent on an individual's genomic data, is a powerful tool to develop for both preventative medicine and personalized treatment.



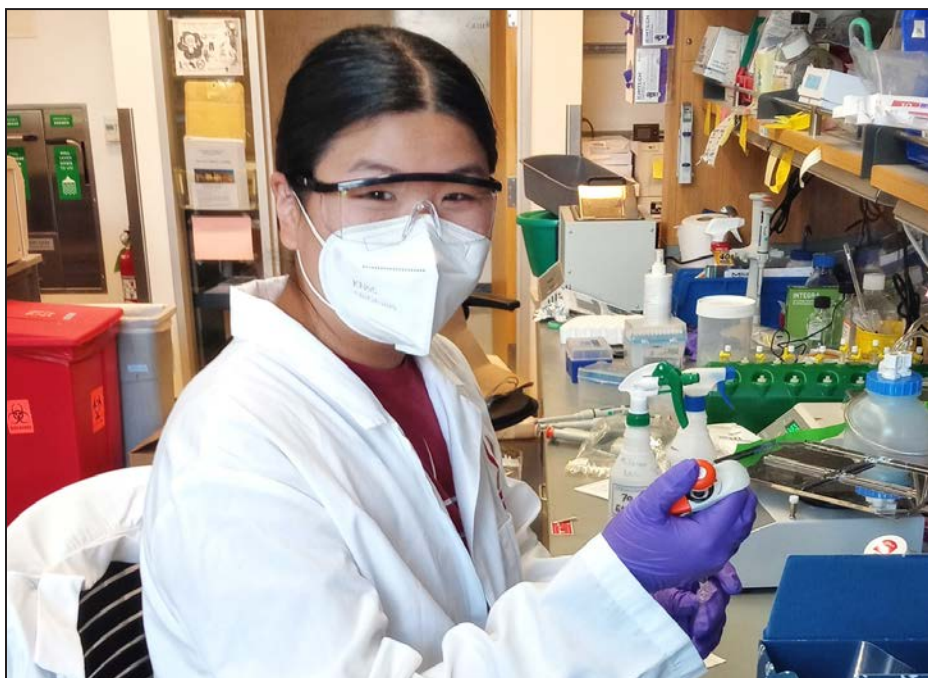
Cheyenne Sadeghi, Mathematics

Mentor: Richard Frock (Radiation Oncology - Radiation & Cancer Biology)

Application of HTGTS (High Throughput, Genome-Wide Translocation Sequencing) to Confirm *de novo* Deletions and Duplications at Recombination Hotspots in Mouse Germlines

Numerous DNA double-strand breaks (DSBs) arise during meiotic cell division (meiosis) to initiate genetic recombination. These DSBs are usually repaired correctly, but in this project, Cheyenne will try to confirm a distinct type of mutational event in which mutations (i.e. deletions) form via joining of ends from two closely spaced DSBs (double cuts) within a single chromosomal location containing numerous mutations (hotspot) or at adjacent hotspots on the same or different chromosomal halves (chromatids). Deletions occur in normal meiosis but are much more frequent when DSB formation is dysregulated in the absence of the DSB repair enzyme, ATM kinase. Mutational events between chromosomes point to multi-chromatid damage and aborted gap repair. Some deletions contain DNA from other hotspots, indicating that double cutting at distant sites promotes insertion mutations. End joining at double cuts can also yield tandem duplications or extrachromosomal circles. Cheyenne is preparing to assay DSB repair using HTGTS from two different meiosis-specific hotspot regions on chromosome 1 in normal and germline cells (spermatocytes) without ATM kinase. This work will provide new valuable mutational data to confirm whether the rearrangements of chromosomes within mouse germline cells are random events or systematic.





Alice Wang will complete her Stanford Bio-X summer research training with Dr. Robbie Majzner

Ximena Sanchez Martinez, Biology and Comparative Studies in Race and Ethnicity

Mentor: Casey Gifford (Pediatrics - Cardiology)

Understanding the Role of NKX2-5 in Congenital Heart Disease.

The NK2 homeobox 5 (NKX2-5) gene encodes a transcription factor involved in heart formation and development. The goal is to learn the extent to which left ventricular noncompaction (LVNC) is dependent on the NKX2-5 variant modifier, that alters the protein's phenotypic function. The Gifford lab and Ximena will examine the cardioid differentiation outcomes of three LVNC related human induced pluripotent stem cell (hiPSC) lines: unaffected, asymptomatic LVNC, and childhood-onset LVCN. When evaluating the outcome of these differentiations, they will focus on the cavity formation and gene expression results to gain a better understanding of the phenotypic differences between the hiPSC lines and identify the cell types involved in LVNC. Then, they will take these results and compare them to the cardioid differentiation outcome of a corrected NKX2-5 hiPSC line. Results will allow us to understand how NKX2-5 functions as a modifier of congenital heart.



Alice Serenska, undeclared

Mentor: Gary Darmstadt (Pediatrics - Neonatal & Developmental Med.)

Variation in the Rates of Sexual Assault Crisis Counselor Utilization During Forensic Examination in California

Using 2019 data from California's Department of Justice and Office of Emergency Services as well as the FBI's Uniform Crime Reporting program, Alice will compare attendance of sexual assault crisis hospital counselors with post-assault forensic evidence collection kits per county in California. In the case of unavailable or incomplete data due to inter-agency discrepancies, she will perform simple modeling analyses to determine variation in counselor implementation and gain insights into interventions to promote their increased usage. Utilizing quantitative evidence, she will also address these inconsistencies as part of a larger accountability effort to illuminate ongoing issues with data accuracy and transparency.



Michelle Shen, Bioengineering**Mentor: Tanya Stoyanova (Radiology)****Combination with Notch I Antibody Enhances Second-Generation Anti-Androgen Treatments in Aggressive Prostate Cancers**

Prostate cancer is the most common cancer and the second leading cause of cancer death in men. While prostate cancers initially respond to first-line, anti-hormonal therapies, aggressive subtypes can emerge and become resistant to anti-androgen treatments. Thus, re-sensitizing these resistant cancers can improve patient prognosis and survival. Notch I signaling pathway has been identified as a critical factor in prostate cancer proliferation and invasion. Both Notch I inhibition and deletion were synergistic with anti-androgen therapies. Thus, the goal of Michelle's project is to test the therapeutic efficacy of combination therapy between the Notch I-inhibiting antibody, Brontictuzumab, and anti-androgen treatments in aggressive prostate cancers.

Maya Somers, undeclared**Mentor: Paul Bollyky (Medicine - Infectious Diseases and Microbiology & Immunology)****Investigating the Association of Pf Bacteriophage with Pa Antibiotic Tolerance and Resistance in the CF Airway**

Pseudomonas aeruginosa (Pa) infection is typically found in the airways of patients with Cystic Fibrosis (CF) and establishes biofilms, slimy collections of microbes and extracellular polymers, in the airway. The Bollyky lab has hypothesized that Pf bacteriophage virus infecting Pa, promote Pa antibiotic tolerance and increase the likelihood of genetically encoded antibiotic resistance. This summer, Maya will study Pa isolates from CF sputum samples to determine if Pf phage is associated with antibiotic tolerance and resistance. She will utilize a Minimal Biofilm Eradicating Concentration (MBEC) assay to conduct antibiotic susceptibility testing of the biofilms and investigate genetically encoded antibiotic resistance in the Covert Lab. This study will improve our understanding of Pf association with Pa antibiotic resistance.

Marc Soong, Music**Mentor: Lauren O'Connell (Biology)****Hormonal and Acoustic Drivers of Parental Coordination in a Poisonous Frog**

Teamwork between parents ensures family survival. Interparental communication is the foundation for infant social success and positive health outcomes. This communication is modulated by acoustic or hormonal factors. The biparental poison frog *Ranitomeya imitator* produces calls that vary with different social tasks, such as infant care and mating. Using these poison frogs, Marc will (1) record, quantify, and compare call characteristics, focusing on social calls during mating and parenting, (2) use enzyme-linked immunoassays (ELISAs) to measure hormonal concentrations depending on frog temporal behavior, and (3) pair call characteristics with hormonal candidate correlates, and statistically analyze whether a correlation exists. This work will shed light on both acoustic and molecular factors key to interparental communication in a vertebrate model.

Ryan Suh, undeclared**Mentor: Tony Wyss-Coray (Neurology & Neurological Sciences)****Uncovering the Aging Brain Vascular Mucinome**

Preliminary data from the Wyss-Coray lab have revealed that mucins, a crucial class of O-linked glycans, are expressed at significantly lower levels (downregulated) in the brain vasculature with age and Alzheimer's disease. To determine the associated consequences on vascular integrity and brain health, Ryan will first identify the age-downregulated mucin proteins using an optimized mucin-binding bead enrichment strategy combined with in-house mass spectrometry-based proteomics. He will then conduct statistical analyses on these data and subsequently validate identified proteins using confocal imaging and western blot. Time permitting, he will also begin generating genetic knockouts or removal of these age-dysregulated mucin proteins for in cell and in live subject studies. This work will identify mucin proteins that play a significant role in maintaining a healthy brain.

Praveen Sundar, Engineering

Mentor: Jon-Paul Pepper (Otolaryngology - Head & Neck Surgery)

Surgical Implantation Efficacy of 3D Printed Nerve Conduits



Surgical 3D-printed implants are prominent for patient-specific treatments. The Pepper lab focuses on nerve regeneration after injury. The research conducted in this project will include designing and printing 3D nerve conduits in cylindrical or rectangular shapes to promote tissue revascularization after nerve injury repair. These models will be printed with type I collagen, and with and without mouse nerve fibroblasts. They will test various print designs qualitatively and quantitatively (i.e., tensile strength testing). Along with the 3D nerve conduit, they will identify a combination of fibrin and thrombin to "seal" nerve repairs, with ideal viscoelastic properties, such as setting within a 15-30 second range. This combination of fibrin/thrombin can then be used to fixate the nerve repair conduits in patients. Ultimately, they hope to improve their understanding of how to best repair nerve injuries.

Natalie Tan, undeclared

Mentor: H. Craig Heller (Biology)

Effect of Pentylenetetrazole on Beta-Amyloid Plaque Aggregation in Alzheimer's Disease in the Ts65Dn Mouse Model of Down Syndrome



Previous studies show that Down Syndrome increases the risk of developing early-onset Alzheimer's Disease (AD). Further studies have shown that the neurotransmitter (GABA) receptor inhibitor called pentylenetetrazole (PTZ) may restore cognitive function and mitigate GABA impairments that contribute to AD in mice. The purpose of this project is to analyze the impacts of PTZ on the onset of Alzheimer's in a Down Syndrome (Ts65Dn) mouse model. Using the brains of control and Ts65Dn mice (age 12+ months) with either saline or PTZ, Natalie will use techniques including cryostat sectioning and beta-amyloid staining to histologically analyze the buildup of beta-amyloid deposits in the hippocampus and cerebellum. This experiment will help elucidate the effects of GABA receptor inhibition on AD progression in the context of Down Syndrome.



Cheyenne Sadeghi will complete his Stanford Bio-X summer research training with Dr. Richard Frock (pictured at right)



Briana Martin-Villa will complete her Stanford Bio-X summer research training with Dr. Sarah Heilshorn

Irawadee Thawornbut, undeclared

Mentor: Todd Coleman (Bioengineering)

Investigation of Gut-Brain Interactions in Positive and Negative Social Interactions Using the Electroencephalogram and Electrogastrogram

Irawadee's research project focuses on how interoception, sensation from within the body, plays a role in social interaction through studying to what extent gut and brain interact. This research will first analyze patterns in brain and gut activities (i.e., electroencephalogram (EEG) and electrogastrogram (EGG) signals, respectively) in an individual during a collaborative video game followed by measuring EEG synchronization between that individual and their partner. If the results of this research are significant, findings can be used to maximize team performance and applied to using brain and other nervous signals to create biomarkers for how well people will perform in team sports. This research combines the use of signal processing and neuroscience with the study of human performance in social interactions.



Sofia Vera Verduzco, undeclared

Mentor: Gen Shinozaki (Psychiatry & Behavioral Sciences)

Epigenetics Investigation of Neuroinflammation and Aging in the Context of Post-Operative Delirium

Sofia will be mainly working on two projects, both related to Delirium, a devastating condition among elderly patients that results in significantly reduced mental abilities and awareness. The first project is a clinical study to develop a novel small bispectral electroencephalography (BSEEG) device at the Stanford Hospital, where she will be conducting patient interviews, assessing mental status and recording EEG signals. Additionally, she will be learning how to analyze the collected data. Her second project is an analysis of large-scale genome-wide epigenetic (DNA methylation) data from human subjects using R-programming. She will be in search of promising biomarkers of Delirium. This work is of great importance as it uses novel approaches for detection of Delirium and investigates the pathophysiology of Delirium. Successful outcomes of these projects can lead to better patient care and potential discovery of new treatment for Delirium in future.



Karthik Vetrivel, undeclared
Mentor: Bianxiao Cui (Chemistry)
Multifunctional Neural Interfaces



The overarching goal is to build ultra-flexible, multifunctional neural probes that simultaneously express optical stimulation and electrical recording modalities to establish bidirectional brain-computer interfaces. The project consists of three parts. (1) Development of electronic hardware controllers and printed circuit board (PCB) connectors for flexible neural probes; the Cui lab will seek more efficient ways of powering and controlling individual light-emitting devices. Additionally, these electronics will be combined with standard electrophysiology recording systems, such as Intan. (2) Software development for data acquisition and activation of LEDs in combination with electrophysiology inputs. (3) Neural probe assembly and performance testing in neural cells. They will produce neural probes capable of both stimulating and receiving neuronal activity that will be highly useful in a wide range of future applications.

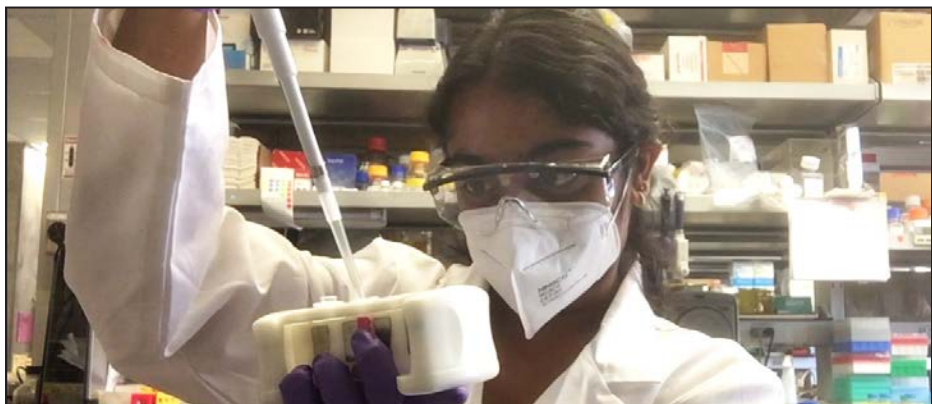
Iyshwary Vigneswaran Warren, Bioengineering
Mentor: Soichi Wakatsuki (Photon Science Directorate and Structural Biology)
Development of a Mutant Photoactivatable Active Site for Time-Resolved Crystallography



The aim of this research is to collect information on structural dynamics from time-resolved, serial femtosecond (factor of 10^{-15}) crystallography (SFX) to elucidate how the protein, 3CLpro, the main protein degrading enzyme (protease) found in coronaviruses, distinguishes between viral and host-cell substrates. To achieve this requires first, designing, synthesizing and crystallizing photoactivatable SARS-COV2 3CLPro by incorporating caged-cysteines at its active functional sites. Second, establishing protocols for activating the protease in crystals for time resolved SFX. The above steps use laser excitation and pump-and-probe X-ray Free Electron Laser SFX (XFEL-SFX) to elucidate protein dynamics of the protease in complex with human protein substrates. These steps all lead to performing complete, multimodal, time-resolved experiments which will help elucidate the structural and functional dynamics of a key protein involved in SARS-COV2 pathogenesis.



Jordan Kimia will complete his Stanford Bio-X summer research training with Dr. Daniel Jarosz



Pooja Akella will complete her Stanford Bio-X summer research training with Dr. James K. Chen

Arvie Violette, Bioengineering

Mentor: Kerwyn Casey Huang (Bioengineering and Microbiology & Immunology)

Novel DNA Damage Repair Gene in *Bifidobacterium Breve*

Using a chemical-genetic screen of a transposon-insertion library in the gut commensal and probiotic *Bifidobacterium breve*, the Huang lab identified BBR_RS10560 as a protein with unknown function whose disruption results in an altered observable characteristic or phenotype that suggests the protein plays a role in DNA damage repair. To elucidate the function of BBR_RS10560, Arvie will analyze phenotypes from mutants in BBR_RS10560 and experimentally proven DNA damage-repair genes. She will quantify the minimal inhibitory concentration (MIC) of chemical mutagens (Mitomycin C, metronidazole, nitrofurans) and viability after ultraviolet light exposure, and track BBR_RS10560 localization by tagging with anaerobic fluorescent proteins. These interdisciplinary experiments will provide insight into the critical process of DNA repair.



Sarah Visokay, undeclared

Mentor: Allan Reiss (Psychiatry & Behavioral Sciences)

Functional Neuroimaging of the Cognitive Load of Exercise in Attention Deficit/Hyperactivity Disorder

Functional Near-infrared Spectroscopy (fNIRS) will be used to monitor brain activity in 80 adolescent participants with Attention-deficit/Hyperactivity Disorder (ADHD) before, during, and after cycling exercise, either indoors (i.e., low cognitive load) or outdoors (i.e., high cognitive load). This experiment is designed to uncover the neural mechanisms involved in the acute response to exercise in individuals with ADHD, which will further develop how exercise is prescribed to these patients. Sarah will be involved in all aspects of the experiment including protocol administration, troubleshooting, and data analysis. This will include learning the technical aspects of fNIRS and patient safety monitoring during exercise.



Alice Wang, Biology

Mentor: Robbie Majzner (Pediatrics - Hematology & Oncology)

Novel Ganglioside Centered Immunotherapy for Pediatric Cancers

Disialoganglioside GD2, a cell surface glycosphingolipid is a useful biological marker for many cancers and target for immunotherapy, however mechanisms underlying oncogenesis are poorly understood. To elucidate the cell death mechanism and possible signaling pathway behind GD2 activation in pediatric cancers, Alice will perform gene expression experiments and functional studies (e.g. knock-out and overexpression of candidate genes followed by assessment of induced cell death assays). She will also learn and perform tissue culture, cell line maintenance, ganglioside screening by flow cytometry, phagocytosis assays, and cloning and testing of constructs for ganglioside overexpression and regulation. This work will illuminate the importance of various genes for the induction of cell death after GD2 activation.



Katy Werwath, Computer Science

Mentor: Laramie Duncan (Psychiatry & Behavioral Sciences)

Investigating the Biology of Mental Illness through Genetics



Mental health problems like depression are among the world's most debilitating conditions. The precise role of hormones in depression has long been suspected, but small sample sizes have hindered research. Building on recent findings from the Duncan Lab about shared genetic factors for menopause symptoms and depression, Katy will conduct the largest ever study of menopause symptoms and mental health (sample size >1 million). In doing so, Katy will learn statistical analysis methods such as genome wide association study (GWAS) and Mendelian Randomization, as well as the skills needed for large computational projects. Katy's work will help to clarify the underlying genetic factors related to menopause symptoms and depression.

Ahmed Yousif, Bioengineering

Mentor: Thomas Südhof (Molecular & Cellular Physiology)

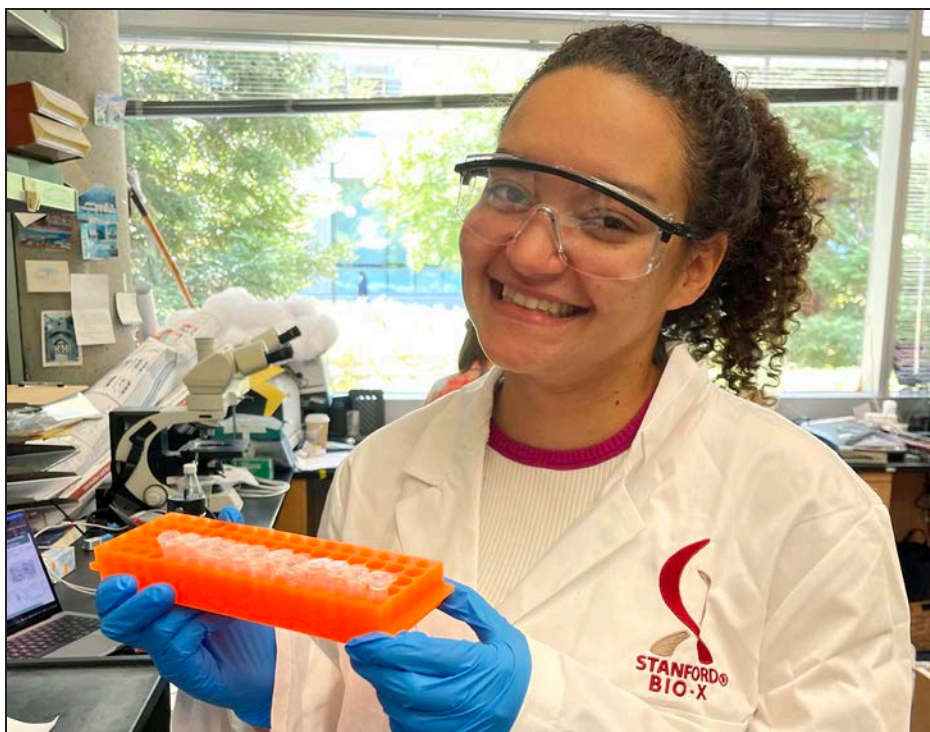
The Molecular Mechanisms Underlying BAI-Adhesion GPCRs' Regulations of Neuronal Development



Brain-specific angiogenesis inhibitors (BAI) are adhesion G protein-coupled receptors (GPCRs) and are crucial in nervous system development and have been implicated in various neurological diseases. The Südhof lab's primary goal is to elucidate the physiological functions and molecular mechanisms of BAIs (BAI1-3) in neuronal development using genetically engineered mouse models. Deletion of the BAI3 gene in transgenic mice, shows that BAI3 promotes synapse formation while inhibiting dendritic branching. Since BAI3 interacts with different ligand molecules (including RTN4Rs and C1qls) one important question is whether BAI-RTN4R and/or BAIs-C1ql interactions contribute to synapse formation and dendritic branching. First, since they have observed significant synapse formation deficit in neurons without the BAI3 gene, Ahmed will examine the expression levels of multiple synaptic proteins in these cells by western blotting. Second, he will analyze imaging data of neuronal morphology using Fiji software to understand the roles and mechanisms of BAIs in neuronal development. Third, he will perform genotyping analysis to identify genetically purebred transgenic mice for breeding using techniques such as Polymerase Chain Reaction (PCR). This work will aid in clarifying the function of BAI receptors in nervous system development and consequently neurological diseases.



Ailsa Craven will complete her Stanford Bio-X summer research training with Dr. Karla Kirkegaard

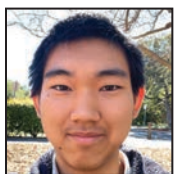


Allegra Minor will complete her Stanford Bio-X summer research training with Dr. Laura Attardi

Albert Zhang, undeclared

Mentor: Markus Covert (Bioengineering)

Integrating Differential Decay of Polycistronic mRNAs into the *E. coli* Whole-Cell Model



The bacterium *Escherichia coli* whole-cell modeling project seeks to create a mechanistic, computational model of an *E. coli* cell. The project currently includes 43% of characterized genes and may prove a powerful tool for predicting complex behaviors. Predictions will help generate new experimental hypotheses, aid in bioengineering design, and integrate diverse datasets. Albert will mathematically and computationally model the widespread phenomenon of varying decay rates between mRNAs from the same gene cluster, which fine-tunes gene expression, and seek to integrate his model with Python into the whole-cell model. He will then experimentally validate his model with fluorescence-based or sequencing-based measurements of gene expression and RNA degradation. This work will help refine the Covert lab's *E. coli* whole-cell model to better support their research of cellular functions.

Allison Zhang, Biology

Mentor: Irving Weissman (Pathology and Developmental Biology)

Recognition and Phagocytosis of Cancer Cells by Macrophages



Humans have developed specialized defense mechanisms to detect and remove old, damaged and harmful cells from the body to maintain homeostasis. Macrophages are responsible for one such mechanism, phagocytosis: the process of detecting and engulfing unwanted material, including cancer cells. The protein Calreticulin (CRT) has been implicated as an important pro-phagocytic "eat-me" signal in various human cancers that is secreted by macrophages to label target cells. In this project, the Weissman lab and Allison will work towards a comprehensive understanding of mechanisms through which macrophages shift to promote CRT expression and secretion to understand phagocytosis and apply it to the development of new therapeutic strategies for life-altering diseases.

2022 Stanford Bio-X Undergraduate Summer Research Program Cohort Leads:

Tony Chang, undeclared

Mentor: Paul Bollyky (Medicine - Infectious Diseases and Microbiology & Immunology)

Capitalizing on Bacteriophage/Antibiotic Synergy to Treat Lung Infections



Pseudomonas aeruginosa (Pa) lung infections remain a leading cause of morbidity and mortality in patients with Cystic Fibrosis (CF). Pa produces biofilms and hinders the penetration of inhaled antibiotics. Novel therapeutic approaches are needed to defeat antibiotic resistance in CF lung infections. Bacteriophage, viruses that kill bacteria, are used in cutting edge therapies for treating chronic lung infections. The Bollyky lab finds that phage OMKO1 acts synergistically with commonly used antibiotics against Pa infections. However, the mechanism by which OMKO1 penetrates biofilms and positively influences the activity of antibiotics is unknown. They will explore and understand the mechanism of OMKO1 enhanced antibiotic penetration of sputum biofilms in pursuit of novel therapeutic approaches to drug resistant lung infections.

Alanna Dorsey, Human Biology

Mentor: Marion Buckwalter (Neurology & Neurological Sciences and Neurosurgery)

Investigating the Effects of Angiogenesis on Vascular Homeostasis in the Mouse Brain Following Hypertension and Stroke



Formation of new blood vessels (angiogenesis) impacts brain homeostasis and is affected by hypertension and stroke, however combinatorial effects are not well understood. Preliminary data in the Buckwalter lab implicates angiogenesis in post-stroke dementia in humans, which is exacerbated by hypertension. In this project, Alanna will quantify angiogenesis in mice that have experienced different combinations of hypertension and stroke. She will evaluate both plasma and brain sections for biomarkers of stroke and angiogenesis utilizing confocal microscopy and image analysis. The results will determine the angiogenic profile in a hypertension mouse model while revealing the impact of hypertension on angiogenesis after stroke.

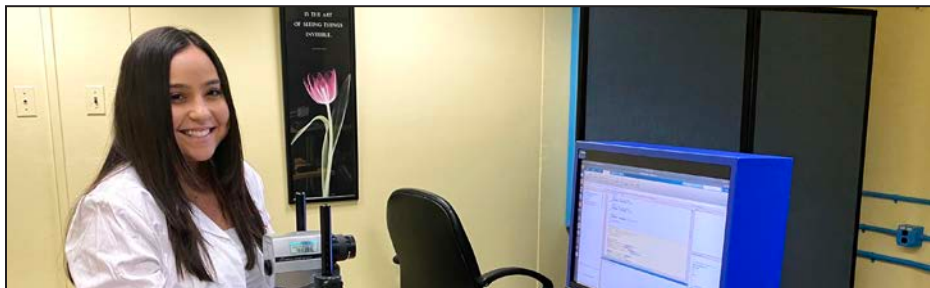
Benjamin Midler, Psychology

Mentor: Shaul Druckmann (Neurobiology and Psychiatry & Behavioral Sci.)

Decoding Higher-Order Neural Representations of Navigation



Navigation is a core neural function that integrates sensory input with internal states to produce a motor output. While progress has been made towards understanding the sensory and mechanical aspects of navigation, it is unknown how self-conception integrates with navigational processes. The default mode network (DMN) is a system of brain structures associated with self-referential thinking. With respect to navigation, the DMN is believed to be vital for integrating self-conception with neural representations of space to produce a goal-congruent motor output. This project hopes to clarify the relationship between self-conception and the neural representation of space through neural recordings from mice DMN performing a VR navigation task.



Katelyn Osuna will complete her Stanford Bio-X summer research training with Dr. Jason Yeatman



De'Angelo Hermesky will complete his Stanford Bio-X summer research training with Dr. Birgitt Schuele

Andrew Song, Human Biology

Mentor: Marion Buckwalter (Neurology & Neurological Sciences and Neurosurgery)

Evaluating the Effect of SARM1(-/-) on Immune Response Following Ischemic Stroke

Prior work in the Buckwalter Lab has demonstrated an elevated inflammatory response specifically in the white-matter regions of the brain following ischemic strokes. Cellular localization of immune cell B-Lymphocytes and Monocytes in areas where post-ischemic axon degeneration occurs indicates the possibility that antigens released when axons degenerate may trigger and sustain a chronic inflammatory response, which contributes to the progressive decline in cognitive function. Specific goals for Andrew's project are threefold. (1) He will learn the techniques necessary to perform stroke surgeries on live normal mice and mice missing the Sterile alpha and TIR motif containing 1 (SARM1) gene, a member of the Toll/Interleukin receptor-1 family responsible for triggering an immune response. (2) Using immunohistochemistry, he will stain the brain tissues following stroke to identify axonal structures to evaluate the degree of axonal survival. (3) Lastly, he will apply confocal microscopy to obtain a 3-D view of brain images and characterize proteins and antigens associated with specific immune cells to assess the degree of immune response. His project will therefore focus on investigating the degree of axonal survival, as well as assessing innate and adaptive immune responses following stroke injury.



Waymon Whiting IV, Human Biology

Mentor: Laura Dassama (Chemistry)

Using a Probiotic Yeast to Secrete a Lysin Antibiotic Against *Clostridioides Difficile* Infection

Waymon will develop a yeast-based delivery vehicle for the antimicrobial enzyme, lysin PlyCD1-174, to target recurrent *C. difficile* infection. *Saccharomyces boulardi* is generally recognized as safe, has showed promise as a probiotic to ameliorate *C. difficile* infection and has been used to secrete antibodies to neutralize *C. difficile* toxins. He will first clone the recombinant lysin PlyCD1-174 into a vector and transform this into *S. boulardi*. After confirming expression via an SDS-PAGE gel, he will perform multiple assays evaluating the crude extract antimicrobial ability against *C. difficile* and other commensal bacterial strains to validate this proof of concept in the lab. This project will provide insight into a novel antibiotic delivery system aimed to address *C. difficile* infections, one of the most importunate threats of antibiotic resistance today.



Stanford Bio-X Undergraduate Summer Research Program



2017 Stanford Bio-X Undergraduate Summer Research Program Participants

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