STANFORD
BIO-X

2019 Stanford Bio-X Undergraduate Summer Research Program Participants

UNDERGRADUATE SUMMER RESEARCH PROGRAM 2019

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UNDERGRADUATE SUMMER RESEARCH PROGRAM

2018 Undergraduate Summer Research Program (USRP) Participants

The Stanford Bio-X Undergraduate Summer Research Program (Stanford Bio-X USRP) is now 15 years old and has partnered with 288 Stanford faculty mentors in order to provide a ten-week summer research opportunity to 637 students to date. Our 2019 cohort includes 63 students and 4 student mentors.

The program aims to foster the interdisciplinary spirit of Stanford Bio-X in a new generation of up-and-coming scientists by exposing Stanford undergraduates to **ten weeks of hands-on laboratory research experience**. In addition to the ten weeks of laboratory research, students attend **weekly faculty talks** by thirty Stanford Bio-X affiliated faculty members to introduce them to the cutting-edge research taking place in laboratories across campus. The program concludes with a **scientific poster session** alongside graduate students, faculty, and Stanford Bio-X community members from across campus and beyond.

Funding for the support of our program was provided by generous contributions from Linda and Andrew Ach, The Rose Hills Foundation, Andrea and Lubert Stryer, Brian and Karen Mariscal in honor of Judy Pinsker-Smith, the Stanford University Vice Provost for Undergraduate Education, Stanford Bio-X, and Anonymous Donors.

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2019 STANFORD BIO-X UNDERGRADUATE RESEARCH PROGRAM TALKS BY STANFORD FACULTY:

June 26

Manu Prakash (Bioengineering), "Gravity machine: A virtual reality platform for single cells"
Theo Palmer (Neurosurgery), "Modeling gene-immune interactions in altered neurodevelopment"
Fan Yang (Orthopaedic Surgery and Bioengineering), "Biomaterials as 3D cell niche: From stem cell-based tissue regeneration to bioengineered cancer models"

July 3

Stanley Lei Qi (Bioengineering and Chemical & Systems Biology), "Synthetic genomics: The new era of genetic engineering"
Marion Buckwalter (Neurology & Neurological Sciences and Neurosurgery), "Post-stroke dementia"
Shirit Einav (Medicine – Infectious Diseases and Microbiology & Immunology), "Towards better understanding and predicting severe dengue"

July 10

Carla Shatz (Biology and Neurobiology), "Synapses lost and found"
Alfred Spormann (Civil & Environmental Engineering and Chemical Engineering), "New carbon-neutral energy technologies by microbial electrosynthesis"
Nirao Shah (Psychiatry & Behavioral Sciences and Neurobiology), "Genetics of social behavior: Understanding how we mate, fight, and parent"

July 17

Shaul Druckmann (Neurobiology and Psychiatry & Behavioral Sciences), "Interpreting neural population recordings"
Calvin Kuo (Medicine – Hematology), "Modeling diseases with organoid cultures"
Brian Kobilka (Molecular & Cellular Physiology), "Structural insights into G protein coupled receptor activation"

July 24

Roger Kornberg (Structural Biology), "Chromosome structure and transcription"
Karl Deisseroth (Bioengineering and Psychiatry & Behavioral Sciences), "Illuminating the brain"
PJ Utz (Medicine – Immunology & Rheumatology), "Physician scientist careers for MD-only and dual degree MDs"

July 31

Carolyn Bertozzi (Chemistry), "Taming the glycocalyx"
Jennifer Cochran (Bioengineering), "Engineering next-generation cancer therapeutics"
Keren Haroush (Neurobiology), "Uncovering the Neural code of complex cognitive computations: The example of social cooperation"

August 7

Michelle Monje (Neurology & Neurological Sciences), "Myelin plasticity in health and disease"
Joseph Woo (Cardiothoracic Surgery), "Cardiovascular surgical repair and regeneration strategies"
Richard Zare (Chemistry), "Mass spectrometry in the service of human health"

August 14

Tom Südhof (Molecular & Cellular Physiology), "The enigma of synapse formation"
Sergiu Pasca (Psychiatry & Behavioral Sciences), "The hidden biology of the human brain"
Euan Ashley (Medicine – Cardiovascular Medicine, Genetics, and Biomedical Data Science), "Your Heart Counts"

August 21

Markus Covert (Bioengineering), "An integrated, multiscale approach for understanding infection"
Peter Jackson (Microbiology & Immunology), "Controlling stem cell differentiation"
Jennifer Raymond (Neurobiology), "Metaplasticity: How does a neural circuit learn to learn?"

August 28

Tony Wyss-Coray (Neurology & Neurological Sciences), "Young blood for old brains"
Lucy O'Brien (Molecular & Cellular Physiology), "It takes a village: Collective dynamics of stem and differentiated cells"
Tim Stearns (Biology and Genetics), "How the nose knows: A journey into the cell biology of olfaction"

Stanford Bio-X Undergraduate Summer Research Program Alumni:

Alumni of the program are extremely successful. They have gone on to pursue doctorates and medical degrees all over the world, publish in high-impact journals, and accept exciting positions in industry and beyond.

2017 Stanford Bio-X Undergraduate Summer Research Program participant Ashley Utz in the lab of Dr. Carolyn Bertozzi.

Pradeep Rajendran, 2008 cohort (pictured at left), is a co-founder and the Chief Scientific Officer at NeuCures, a startup that is pioneering neuroscience-based treatments for heart disease. Pradeep completed an MD/PhD at UCLA and has co-authored 21 publications and received 3 fellowships.

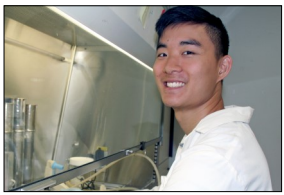
Cheri Dijamco Wu, 2010 cohort (right), is a physician at Stanford Health Care. She will be starting a Child & Adolescent Psychiatry fellowship in 2019 and has co-authored publications in the *Psychiatric Rehabilitation Journal* as well as the *Journal of Affective Disorders*.

Catherine Lu, 2011 cohort (left), is a Principal at Spike Ventures, a venture capital firm that fundraises from and invests in the Stanford alumni community. Previously, she was the Director of Product at Datavisor and co-founded the retail AI company Fancy That, which was acquired by Palantir. At Stanford, she built an online platform used by thousands of students and instructors to streamline grading.

Rebecca Triplett, 2016 cohort (right), is an Implementation Manager at the startup Seeker Health, which uses digital campaigns to connect hard-to-find patients with clinical trials. Previously, she interned at NeoSensory, a company working on creating a wearable wristband which translates sound into vibrations to aid in environmental awareness for the deaf and hard of hearing.

Scott Fleming, 2016 cohort (left), is a Ph.D. student in the Biomedical Informatics Training Program at Stanford. He received a Stanford Graduate Fellowship in 2018 and a National Defense Science and Engineering Graduate Fellowship in 2019, and has just published a co-first-author paper in the *Journal of Medical Internet Research*.

Jonathan Wang, 2017 cohort (right), received a 2019 Gates Cambridge Scholarship to pursue graduate studies at the University of Cambridge, after which he will attend UCSF for medical school. Jonathan founded ImpactMed, a nonprofit on impact investments in neuro-health; the Stanford Undergraduate Hospice and Palliative Care program; and the Golden Gate Science Olympiad. He has also co-authored 2 publications.



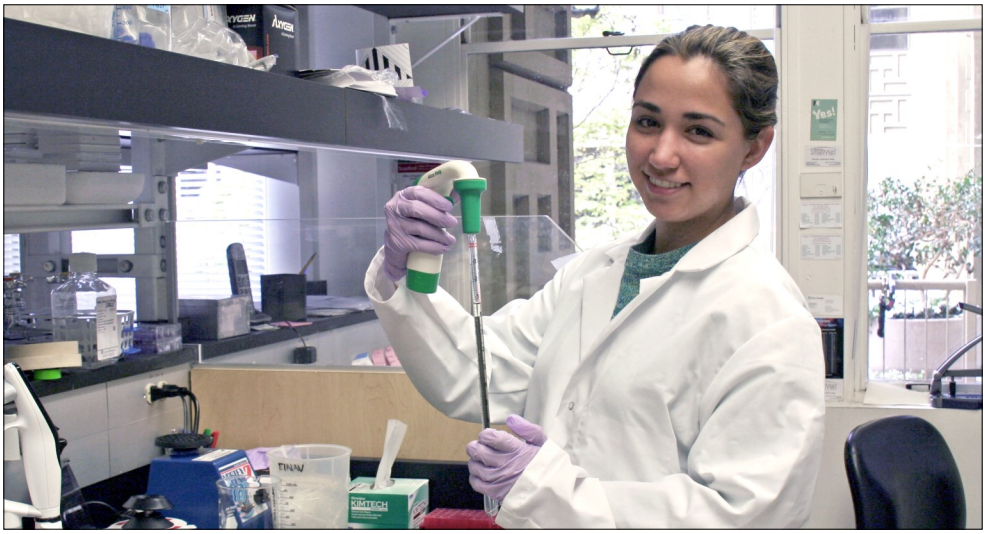
Ashley Utz, 2017 cohort (above), has continued research in the Bertozzi lab but also worked in Munich at Immunic, sponsored by the Krupp Internship Program. After graduation, she will be working at IQVIA and then applying to MD/PhD programs. She co-authored a manuscript in the *Journal of Organic Chemistry* and has another publication in progress.

2019 Stanford Bio-X Undergraduate Summer Research Program Participants:

Nic Becker, Physics
Mentor: Shaul Druckmann, Neurobiology and Psychiatry & Behavioral Sciences
Deciphering Short Term Memory with Machine Learning Models
Understanding the structure of neural activity is key to comprehending how neural circuits represent and process information. Nic will use methods in multivariate statistics and machine learning to model how behavioral features are coordinated in different parts of the brain, providing insight into the unique style of computation achieved in neural circuits.

Brandon Bergsneider, Human Biology
Mentor: Yanmin Yang, Neurology & Neurological Sciences
Narrowing in on the Molecular Mechanisms of Nemitin, a Novel Microtubule Organizing Protein
Neurons rely on a highly organized microtubule structure that controls essential cell functions. Although impairment of this microtubule network is a hallmark of several neurodegenerative diseases, including Alzheimer's, we currently have a limited understanding of the molecular mechanisms by which microtubules are regulated. Brandon's research seeks to further modern understanding of microtubule organization by characterizing the mechanism of action of Nemitin, a newly discovered microtubule organizing protein found in developing cells and in neurons. Identifying Nemitin's mechanism of action will better allow for targeted therapies for neurodegeneration.

Foster Birnbaum, Biology and Computer Science
Mentor: Helen Blau, Microbiology & Immunology
Sarcomere Remodeling in Genetic Dilated Cardiomyopathy
Familial dilated cardiomyopathy (DCM) is one of the most common genetic heart diseases in the United States: genetic DCM affects one in every 1,000 people and can lead to sudden cardiac death in children and adults. While mutations in genes encoding sarcomeric proteins have been implicated in genetic DCM, little is known about how sarcomere remodeling contributes to DCM progression. Foster will develop an image-detection script to identify sarcomeres and combine it with a stem cell-derived heart cell platform to study sarcomere remodeling in DCM.



Avery Muniz, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Shirit Einav's lab

Marlon Washington II, 2019 cohort, completed his Stanford Bio-X summer research training in Dr. Andrew Huberman's lab

Susanna Bradbury, Biology

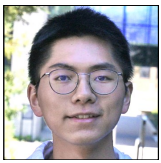
Mentor: Karl Deisseroth, Bioengineering and Psychiatry & Behavioral Sciences

Using Genetic Techniques to Isolate the Roles of Neurotransmitter Types in Homeostatic Threat Response

Animals constantly face threats to internal equilibrium, such as heat or cold, that cause long-term, relatively slow physiological changes by upregulating hormone levels in the blood. Susanna's Stanford Bio-X project seeks to explore the comparably immediate effects of homeostatic stressors in the brain that produce quick behavioral responses such as avoidance. Susanna's research will involve genetically modifying zebrafish using CRISPR technology in order to better understand the neural mechanisms underlying these rapid responses. The results of this study could potentially extend to primates and can be used to inform further studies in other animal models.

Shawn Cai, undeclared

Mentor: Giles Plant, Neurosurgery



***In vitro* Spinal Cord Injury Model Using Stem Cells and Multielectrode Arrays**

Spinal cord injury (SCI) is devastating to patients and affects millions of people. However, current therapy development is limited because rodent models cannot represent some key human neural physiologies. By combining multielectrode arrays and a novel stem cell strategy developed in the Plant laboratory, Shawn will work on building a platform that characterizes long-term cultures of corticospinal neurons, allowing for analysis of their morphology, physiology, and function. This innovative, human-relevant platform will facilitate the development of new SCI therapies.

Rebecca Christensen, Biology

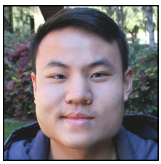
Mentor: Alfred Spormann, Civil & Environmental Engineering and Chemical Engineering

Tracking Sulfate-Reducing Bacteria in Intestinal Diseases

Sulfate-reducing bacteria (SRB) have previously been associated with certain metabolic diseases of the human gut. SRB have been thoroughly catalogued from environmental settings, but despite ongoing research studying the health implications of SRB on the human gut, little is known about these human-specific bacteria communities. Rebecca's research aims to better characterize these communities by using molecular biology techniques to identify sulfate-reducing bacteria species from fecal DNA samples, thus broadening and detailing our understanding of the sulfate-reducing bacteria community profile.

Alea Delmastro, Chemical Engineering
Mentor: Michael Angelo, Pathology
Investigating the Immunological Structure and Composition of Tuberculosis Granulomas with Multiplexed Ion Beam Imaging
Despite its large global burden, the human immune response to *Mycobacterium tuberculosis* remains poorly characterized. Tuberculosis (TB) infection results in the formation of organized immune cell aggregates, known as granulomas, at the site of infection in both clinically latent and active disease. Utilizing multiplexed ion beam imaging and computational methods for single cell analyses, Alea aims to elucidate the composition and structure of these granulomas in order to describe key immune differences distinguishing active TB from latent TB, which can lay a foundation for novel vaccine platforms and host-directed immunotherapies.

Clayton Ellington, Bioengineering
Mentor: Manu Prakash, Bioengineering
Development of a Chip for Collection and Analysis of Mosquito Saliva
Clayton will be helping to develop a chip that attracts mosquitoes and collects their saliva for use in biochemical assays to determine mosquito species and parasite type. This chip will be used to gather data to aid in the mapping and modelling of vector and disease ecology.



Allan Feng, Biology
Mentor: PJ Utz, Medicine (Immunology & Rheumatology)
Multiplexed Serum Autoantibody Profiling of Idiopathic Multicentric Castleman Disease (iMCD)
Idiopathic Multicentric Castleman Disease, also known as iMCD, is the deadliest and most poorly understood subtype of Castleman Disease. Allan's research project will use a customized analytic procedure to identify novel proteins that could be used to fight against iMCD by comparing expression of proteins in healthy and iMCD blood samples.

Anthony Flores, Chemical Engineering
Mentor: Judith Frydman, Biology and Genetics
Chemical and Genetic Modifications to Regulate Mutant Huntingtin Protein Aggregation in Mammalian Cells
Huntington's Disease is a chronic neurodegenerative disease with no curative treatment caused by toxic insoluble protein aggregation within the nuclei of neurons. Anthony will be optimizing reagents that prevent protein aggregation but are limited by poor stability in physiologic conditions. Improvement of the reagents' stability and cellular uptake with these chemical and genetic modifications could mitigate toxic protein aggregation and prevent cell death in Huntington's Disease neurons.

Sara Frigui, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Rajat Rohatgi's lab

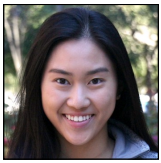
Jessica Frank, undeclared
Mentor: Jennifer Cochran, Bioengineering
Development of a Transgenic Mouse Cell Line to Test Cancer Immunotherapies
Prodrugs—drugs that are inactive when given to patients but become activated at specific sites within the body—offer a promising solution to the problem of treatment-induced autoimmune side effects associated with cancer immunotherapy. To test cancer immunotherapy prodrugs, it is important to design a mouse model that accurately represents how the drugs will perform in humans. Jessica's project focuses on creating a mouse cancer cell line that expresses the human proteins involved in prodrug activation, thereby allowing the Cochran lab to test cancer immunotherapy prodrugs for both efficacy and toxicity *in vivo*.

Sara Frigui, Chemistry
Mentor: Rajat Rohatgi, Biochemistry and Medicine (Oncology)
Uncovering the Mechanism of Transmembrane Proteins in the Hedgehog Signaling Pathway
The Hedgehog signaling pathway mediates communication between cells in both developing and adult tissues. Breakdown of this communication system can cause birth defects, cancer, and degenerative conditions. Sara will investigate how the Hedgehog signal is transmitted across the cell surface from the cell exterior to the cell interior, a step that is commonly damaged in human diseases associated with Hedgehog signaling.

Catherine Gao, Human Biology
Mentor: Theo Palmer, Neurosurgery
Determining the Effects of Maternal Immune Activation on Priming Microglial Responses
Infection during pregnancy has been linked to the development of autism spectrum disorders (ASD) in offspring. Microglia—the primary immune cells in the brain, which are essential for synaptic pruning during development—are implicated in ASD. However, the precise effects of prenatal infection on microglial development and function are not well known. Catherine's research will use a mouse model to explore the lasting consequences of early life events on microglial function and the mechanisms by which prenatal infections may contribute to neurodevelopmental and neuropsychiatric disorders.

Julia Gillette, Psychology and Art History
Mentor: Ian Gotlib, Psychology
Air Pollution, Cellular Aging, and Stress Biology in Adolescents: The Role of Familial Risk for Depression
Air pollution is currently the greatest environmental threat to public health. The broad goal of Julia's Stanford Bio-X research is to examine the ways in which exposure to fine particle air pollution affects child and adolescent development, and to identify psychological traits that will help us understand for whom exposure may be more or less consequential. In a sample of adolescent girls, Julia's project will examine the effects of fine particle air pollution on cellular aging and stress biology, and test whether familial risk for depression compounds these effects.

Jacob Greene, Biology
Mentor: Michelle Monje, Neurology & Neurological Sciences
Microglial Repopulation Dynamics After Chemotherapy
Chemotherapy often results in a host of neurological deficits, including cognitive disruptions. These side effects can be rescued through the depletion of microglia, the resident immune cells of the central nervous system, following chemotherapy treatment. During the summer, Jacob hopes to investigate how microglia repopulate the brain post-depletion in an effort to optimize this microglia depletion therapy.



Sierra Ha, Biology

Mentor: Anthony Oro, Dermatology

Mechanism of Nuclear Lamina Regulation of Tumor Evolution

Sierra's project will combine biochemical, cell biological, and structural biology techniques to better understand how protein variants transport cancer-promoting transcription factors into cell nuclei in resistant basal cell carcinoma. Sierra's research will focus on elucidating the mechanism of how transcription factors interact with these proteins to navigate the complex environment of the nucleoskeleton and disrupt regular cell nucleus structure.

Cynthia Hao, Bioengineering

Mentor: Roger Kornberg, Structural Biology

Amplification and Sequencing for Pooled Genetic Screens in Mammalian Cells

Cynthia's project is to develop a microscopy-based screen that will enable researchers to map complex phenotypes to their corresponding genetic perturbations based on the spatial location of each cell. Her work will expand the capabilities of researchers to characterize the effects of many different genes on mammalian cell phenotypes, such as cell shape and protein interactions, which are observable under a microscope. This could develop into a useful research tool and discovering genes responsible for previously uncharacterized phenotypes.

Maria Paula Hernandez, Bioengineering

Mentor: Joseph Woo, Cardiothoracic Surgery

Engineering Cyanobacteria to Improve Treatment of Coronary Artery Disease

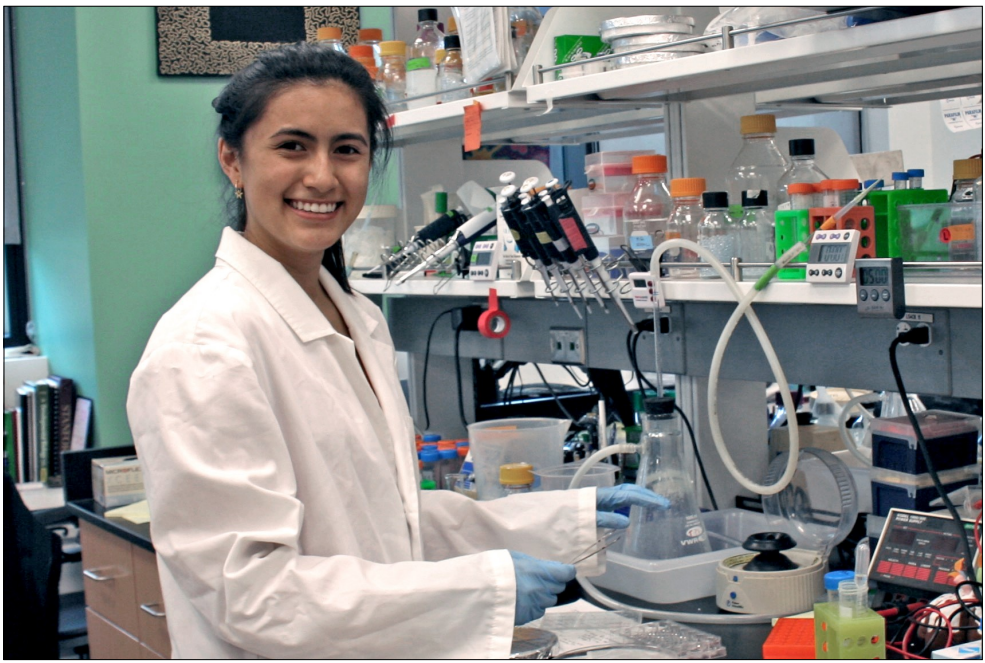
Coronary artery disease is the leading cause of death in America for both men and women, and while major strides have been taken for its treatment, ischemic cardiomyopathy eventually leads to heart failure in many patients. A novel research area is photosynthetic cyanobacteria, which have been shown to oxygenate the heart to treat ischemia and hypoxia, but their potential remains untapped in areas other than oxygen delivery. For Maria's Stanford Bio-X summer project, she will be transforming the cyanobacteria *Synechococcus elongatus* to activate myocardial repair pathways, thus aiding the healing process of the heart and making the treatment more effective.

Emily Huang, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Carlos Bustamante's lab

Samuel Hoelscher, Chemistry
Mentor: Gavin Sherlock, Genetics
Dominance and Pleiotropy: Investigating the Impact of Environment on Heterozygous Effects
Many human diseases are the result of large populations of cells adapting over time—key examples include microbial infection and cancer. Studying adaptation and evolution is critical to understanding these maladies. Sam's research will use CRISPR-Cas9 technology to study homozygous and heterozygous cells' mutations to better elucidate dominance in relationships and how mutations change across different environments.

Emily Huang, Mathematical & Computational Science
Mentor: Carlos Bustamante, Biomedical Data Science and Genetics
Performance of a Standardized Clinical Variant Adjudication Framework
The interpretation of genetic variants for human disease requires synthesizing numerous lines of evidence, from medical case studies to experimental results. Emily will quantify the performance of existing adjudication rubrics developed as part of the ClinGen Gene and Variant Curation Interfaces. By better understanding how medical professionals interpret genetic research, we can better inform the translation of basic research to clinical care.

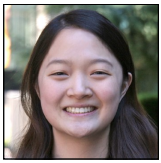
Jared Hysinger, Biology
Mentor: Michelle Monje, Neurology & Neurological Sciences
Defining the Role of Neuronal Activity on the Initiation and Growth of Neurofibromatosis Type I-Associated Optic Glioma
Optic Pathway Gliomas are brain tumors which primarily affect children. Their molecular mechanisms are not well understood, and current therapies are not satisfactory. It is hypothesized that the activity of retinal ganglion cells stimulates the growth of optic gliomas through a specific pathway. Jared's research will focus on analyzing this pathway to work towards determining the mechanisms behind the growth of optic gliomas.



Anaïs Tsai, 2019 student mentor, completed her Stanford Bio-X summer research training in Dr. Tim Stearns's lab

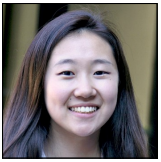
Nic Becker, 2019 cohort, completed his Stanford Bio-X summer research training in Dr. Shaul Druckmann's lab

Andrew Labott, Public Policy
Mentor: Lucy O'Brien, Molecular & Cellular Physiology
Investigating Cellular Differentiation Kinetics During *Drosophila* Intestinal Homeostasis
The O'Brien lab studies how stem cells maintain homeostasis in adult tissues using the *Drosophila* midgut as a model. Andrew will be using novel molecular biology techniques to study how the rates of stem cell and progenitor cell terminal differentiation differ under various environmental conditions and genetic backgrounds. This research aims to elucidate how cells control their individual differentiation rates in an effort to maintain tissue homeostasis on a whole-organ level.



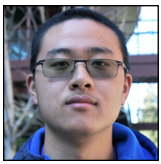
Tracy Lang, Human Biology
Mentor: Peter Jackson, Microbiology & Immunology
Do Cilia Protect Kidney Cells in Hypoxia via a Specific Molecular Mechanism?
The role of primary cilia in cystic kidney disease, and the mechanism by which repair of tissue damage requires regulation of hypoxia, both remain poorly characterized. Using super-resolution localization and cell viability studies, Tracy aims to better understand oxygen-dependent molecular mechanisms in cystic renal tissue by studying the role of a specific enzyme called asparagine hydroxylase as well as ciliary genetics in cystic kidney disease biology.

Kate LeBlanc, Biology
Mentor: Carla Shatz, Biology and Neurobiology
Early Changes in Neural Plasticity in a Mouse Model of Alzheimer's Disease
Alzheimer's disease (AD) is considered a neurodegenerative disease of the aging brain, with adult onset defined by cognitive decline and beta amyloid plaques. However, in mouse models of genetic forms of AD, high levels of soluble beta amyloid (Abeta) are present very early in development, when neural plasticity is needed to sculpt brain circuits. Kate's research will examine if neural plasticity in the visual system is disrupted at these early ages, and whether a drug that blocks Abeta binding to an Abeta receptor in the brain can protect against disruption. These results could point to novel treatments for Alzheimer's disease.



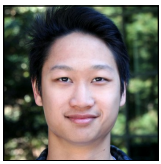
Jiwoo Lee, Computational Biology
Mentor: Hunter Fraser, Biology
Massively Parallel Precise Genome Editing in Mammalian Cells
"CRISPEY" is an efficient modification that uses hybrid RNA molecules to make CRISPR/Cas9 genome editing technology high-throughput in a massively parallel and precise manner. Jiwoo's project aims to modify this approach for mammalian cells in order to study polygenic traits, which are traits controlled by multiple genes, to reveal a deeper understanding of complex human diseases.

Max Lee, Public Policy
Mentor: Tirin Moore, Neurobiology
Characterizing Adrenergic Receptor Expression in the Prefrontal Cortex
Understanding the modulation and expression in the prefrontal cortex of adrenergic receptors, which are the targets of numerous hormones and medications, is key to understanding different cognitive processes like attention and working memory. Max will compare the expression of different classes of adrenergic receptors across different cell types and layers of the frontal eye field, a key area of the prefrontal cortex for these cognitive processes. Max's project will help to understand the role of adrenergic receptors in cognitive circuits, which will have bearing on our understanding of conditions like ADHD.



Andrew Li, undeclared
Mentor: Keren Haroush, Neurobiology
Investigating the Neural Basis of Social Prediction in Primates
Social prediction is central to successful social interactions, but the specific mechanisms underlying its execution remain unclear. Andrew seeks to bridge that gap by investigating how social brain regions in the non-human primate respond when they seek to predict the behavior of other individuals. These insights may help guide treatments in social behavioral disorders.

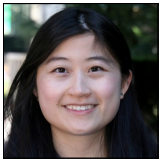
Miranda Li, undeclared
Mentor: Wing Wong, Statistics and Biomedical Data Science
Gene Network Inference of Mouse and Human Single-Cell Sequencing Data
Current bulk gene analysis methods cannot distinguish between subpopulations of cells in a heterogeneous sample, making it impossible to identify differences in the transcriptional profiles of varying cell types, and to the changing composition of cell subpopulations within a sample. The rise of single-cell genomics data allows scientists to differentiate gene expression levels of individual cell types within a heterogeneous sample. Miranda will use a matrix factorization method developed in the Wong Lab to couple different kinds of single-cell sequencing data in order to discover novel genetic regulators of disease and phenotypic variation between cell types. This work has exciting potential applications to all fields of medicine.



Matthew Liao, undeclared
Mentor: Thomas Cherpes, Comparative Medicine
Using a Mouse Model to Develop a Liver-Stage Malaria Vaccine
As malaria causes 450,000 deaths each year, mostly in resource-poor areas, there is an urgent need to develop an effective and affordable malaria vaccine. Matthew's Stanford Bio-X research in the Cherpes lab will use laboratory mice to help develop and test a vaccine that stimulates host T cell immune responses to eradicate liver-stage malaria infection. Matthew will incorporate genetics and data analysis to evaluate the results of this new potential malaria vaccine.

"The Bio-X program was a great way for me to start my research career by working with an amazing faculty member and graduate student. That summer research experience laid the foundation for my future research in oncology."

—USRP Participant Julie Koenig



Fan Liu, Biomedical Computation

Mentor: Howard Chang, Dermatology and Genetics

Characterizing Cell-Type Dependent Circular RNAs to Develop Delivery Therapeutic Platforms

RNA can be utilized as a delivery system for gene expression: more specifically, circular RNAs (circRNAs) can be used as a platform for targeted gene expression due to their stability and long half-life. Fan will use high-throughput library screening and machine learning to develop a systematic method for identifying the ribosome entry sites where circRNAs initiate protein translation. Fan will analyze the differences in these site sequences in different cell types. This will provide insight for future researchers to build circRNA delivery therapeutic platforms.

Jay Liu, Chemistry and Computer Science

Mentor: Justin Du Bois, Chemistry

Developing Synthetic Tools to Study Voltage-Gated Sodium Channels

The Du Bois lab is engaged in foundational research that aims to advance treatment options for nerve cell signaling disorders like epilepsy, cardiac arrhythmia, and chronic pain. The current focus of their work is developing imaging agents for voltage-gated sodium ion channels in live cells, in order to understand how different ion channels are trafficked in dynamic disease settings. Jay will be designing and testing a neurotoxin-based imaging agent, as well as modifying and studying existing agents, in order to investigate therapeutic candidates for channel dysfunction.

Kasey Love, Bioengineering

Mentor: Lei Stanley Qi, Bioengineering and Chemical & Systems Biology

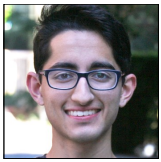
Developing "Sense and Respond" Systems for Logic Gating Applications in Cellular Engineering

Recent developments in CRISPR technologies allow for unprecedented control of cellular behavior. Systems have been developed to engineer "sense and respond" cells that can detect and integrate relevant inputs in order to initiate cellular programs. Using a specific protein developed by the Qi lab, Kasey seeks to implement logic gating into such systems for the development of immunotherapy applications. Her project aims to design a logical gate that can respond to cues from a tumor microenvironment, thereby regulating expression of target genes involved in an anti-tumoral immune response.

Anthony Flores, 2019 cohort, completed his Stanford Bio-X summer research training in Dr. Judith Frydman's lab

Alexis Lowber, Biomedical Computation
Mentor: Wendy Fantl, Urology
Deep Profiling of High Grade Serous Ovarian Tumors by CODEX Multiplex Imaging

High grade serous ovarian cancer tumor (HGSOC) is characterized by a mixture of diverse aberrant cells, which has inhibited the development of a curative treatment. It's been hypothesized that the functionality and survival of specific types of cells residing in the tumors could be greatly dependent on the neighboring tumor, immune, and stromal cells, which could mean that these neighboring cells are possible new targets for treatment. Alexis will work with her mentor on implementing an imaging technology called CODEX to study the neighboring cells in HGSOC samples.

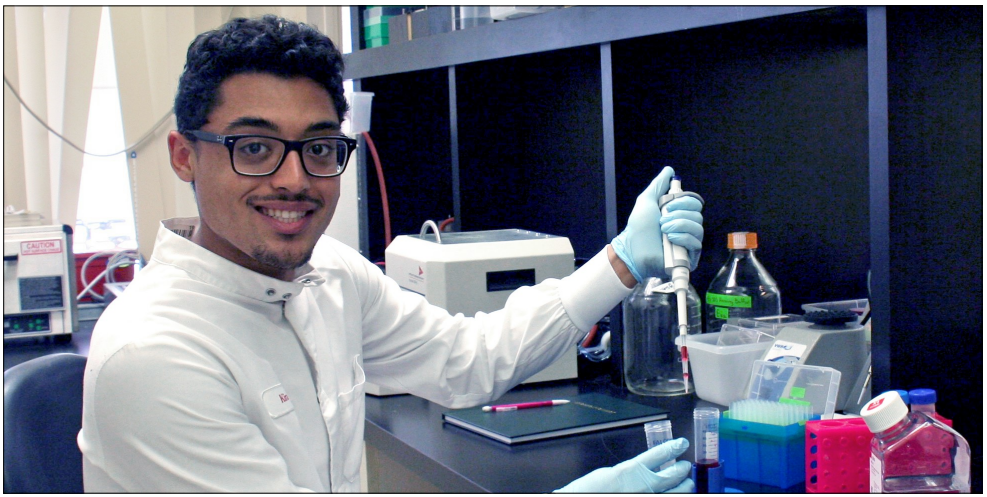


Rohan Mehrotra, undeclared
Mentor: Richard Zare, Chemistry
Diagnosis of Renal Cell Carcinoma with Mass Spectrometric Imaging Techniques

During surgery for cancers such as renal cell carcinoma (RCC) in the kidney, surgeons often have difficulty determining whether all cancerous tissue has been removed at the margin of the resection. During the summer, Rohan will evaluate the feasibility of using desorption electrospray ionization mass spectrometry (DESI-MSI), a technique which provides information on the chemical composition of a sample, to discriminate between RCC-affected kidney tissue and healthy kidney tissue. He plans to develop a statistical model that can classify tissue as healthy or pathological based on a DESI-MSI scan of the sample. If accurate, the model has the potential to assist in surgical decision-making by informing the surgeon whether the entire tumor has been removed.

Omeed Miraftab-Salo, Bioengineering
Mentor: Fan Yang, Orthopaedic Surgery and Bioengineering
Harnessing Tissue Engineered 3D *in vitro* Models to Elucidate Breast Cancer-Bone Metastasis

Using micro-ribbon scaffolds, which promote robust stem cell-based bone formation, Omeed will develop physiologically-relevant 3D *in vitro* models to mimic breast cancer-bone metastasis. He will study the role of breast cancer cells in promoting the destruction of bone tissue and elucidate the effect of bone resorption on breast cancer growth and invasion. Omeed's summer project is at the interface of cancer biology, biomaterials, tissue engineering and orthopaedic surgery and will provide novel 3D *in vitro* cancer models, a powerful tool for enabling discovery of novel molecular targets to treat breast cancer-bone metastasis with reduced materials, time, and cost.



Omeed Miraftab-Salo, 2019 cohort, completed his Stanford Bio-X summer research training in Dr. Fan Yang's lab

"The program gave me a great appreciation for the sheer amount of research occurring just at Stanford. It was wonderful to be surrounded by peers who were all working on such interesting projects. I had definitely not been surrounded by such a motivated group of students in any previous grant program. The weekly lectures were very useful in providing me with directions and techniques to apply to my own project."

—USRP Participant Sam Lawrence

Stephen Moye, Bioengineering

Mentor: Thomas Südhof, Molecular & Cellular Physiology

Characterizing the Role of the ARMCX3 Gene in Synapse Formation

Synaptogenesis, which refers to the formation of synapses and connections between neurons, is an extremely important process in the development of an organism's nervous system. When the gene ARMCX3 is knocked out in human-induced neuron cells, the induced neuron's synapses demonstrate morphological and electrophysiological defects. In his Stanford Bio-X project, Stephen will examine these changes to more fully understand the role of the ARMCX3 gene in synaptogenesis, which could help us to understand neurological and neurodegenerative disorders.

Avery Muniz, Biology

Mentor: Shirit Einav, Medicine (Infectious Diseases) and Microbiology & Immunology

Novel Transcriptomic Approaches to Functional Validation of Predictive Biomarkers for Progression to Severe Dengue

Severe dengue is a major global health threat, but transcriptomics studies based on bulk samples and/or single cohorts have not yielded gene sets that are reliably predictive of progression from infection to severe dengue. Avery will study the transcriptional dynamics of dengue virus infection by using a recently developed approach, virus-inclusive single-cell RNA-Seq, on single human peripheral blood monocyte cells. With this method, she hopes to decipher the roles of individual genes from a 20-gene set that has been validated as predictive of severe dengue. This work could contribute to the understanding of dengue pathogenesis and advance the development of a dengue prognostic assay.

Claire Muscat, undeclared

Mentor: Gerlinde Wernig, Pathology

c-Jun, a Novel Pro-Osteogenic Factor to Treat Osteoporosis and Osteoporosis-Associated Fractures

Osteoporosis and its negative repercussions, such as increased rates of fatality, bone fracturing, and care dependency, affect 44 million people in the United States alone. Conventional osteoporosis treatments, such as calcium and vitamin D supplementation, have been proven to be ineffective, especially if implemented after the primary fracture has already occurred. Claire's project will use a mouse model to test what effects locally inducing the transcription factor c-Jun into a fracture site will have on the overall rate of fracture healing and the resulting bone mass.

Zane Norville, Bioengineering

Mentor: Robert Malenka, Psychiatry & Behavioral Sciences

The Functional Role of Amygdala-Dopamine Interactions in Motivated Behaviors

The amygdala has long been studied for its role in fear and aversion processing, and it can be divided into regions that are thought to serve different behavioral functions. Zane's research combines *in vivo* neuroinhibitory techniques and behavioral assays to better understand the connection between the amygdala and dopamine systems, which has implications for understanding the neural basis of motivated behavior.

Sierra Porter, Biology

Mentor: Marion Buckwalter, Neurology & Neurological Sciences and Neurosurgery

Investigating the Astrocyte Translatome After Stroke

Astrocytes have been implicated as important cells for the regulation of neuroinflammation after stroke. However, the precise signaling pathways by which astrocytes influence neuroinflammation are unknown. Using molecular biology techniques including immunoprecipitation, RT-qPCR, and RNA sequencing, Sierra's project will elucidate how the astrocyte translatome—the body of messenger RNA being translated within the cell—changes after stroke.

Bobby Radecki, Human Biology

Mentor: David Hong, Psychiatry & Behavioral Sciences

PANDA Project

By studying the neurodevelopmental effects of cross-sex hormone therapy used by transgender youth compared to cisgender controls, the Hong lab hopes to improve long-term clinical outcomes for transgender youth. Moreover, studying transgender youth will also provide insight into the role of sex hormones in cisgender development. As well as helping with various project aspects from recruitment to test administration to data analysis, Bobby will focus on the neuroimaging component of the project and will create a full factorial statistical model to analyze subcortical and frontal regions of the brain, which have been historically identified as sexually dimorphic.

John Rees, Biology

Mentor: Catherine Blish, Medicine (Infectious Diseases)

Dengue Virus Regulation of Monocyte Ligand Expression

Dengue virus exists in four different strains, each with different protein structure and genomes. Efforts to create a vaccine against all four serotypes have been largely unsuccessful. Dengue-infected cells express inflammatory ligands, which may also differ by serotype, and which activate an immune response. John aims to use immunological research methods and computational analysis to characterize immune responses to the different serotypes in order to inform the development of a better vaccine.

Alexis Lowber, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Wendy Fantl's lab

Julia Schaepe, Bioengineering

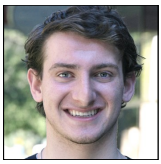
Mentor: Sergiu Pasca, Psychiatry & Behavioral Sciences

Studying Neural Defects Associated with 22q11.2 Deletion Syndrome in 3D Forebrain Assembloids

The lack of access to intact, functioning human brain tissue is a critical challenge in understanding pathogenesis of brain disorders including 22q11.2 deletion syndrome (22q11DS), a genetic disorder which can cause heart and immune system defects and cognitive impairment. By utilizing brain-region-specific 3D cultures assembled from 22q11DS patients, Julia will investigate defects in the migration of a key population of neurons in the cerebral cortex. Julia will develop advanced computational methods with the ultimate goal of developing screens and identifying therapeutics for 22q11DS patients and other interneuropathies.

Ethan Schonfeld, undeclared

Mentor: Gregory Scherrer, Anesthesiology, Perioperative & Pain Medicine and Neurosurgery



Opioids as Demyelinating Agents and Accelerators of Neurodegenerative Disease: Identifying Mechanisms and Therapeutic Strategies

Over 200 million opioids were prescribed in 2016 in the United States alone. Ethan's research in the Scherrer lab will investigate the hypothesis that opioids cause demyelination—damage to the protective sheaths around nerve fibers—and thus trigger or accelerate numerous neurodegenerative diseases, including amyotrophic lateral sclerosis, multiple sclerosis, and dementias. Ethan's research further seeks to identify if this opioid demyelinating effect occurs at a specific receptor on neurons or is due to other processes, such as opioid reception on other brain cells. Ethan will use a mouse knockout model in hopes of elucidating ways to avoid this effect, as well as to better understand the possible role of endogenous opioid reception in the acceleration of neurodegenerative disease.

Jacob Shaw, Human Biology

Mentor: Hadi Hosseini, Psychiatry & Behavioral Sciences

The Effect of Baseline Ability on Improvements in a Specialized Skill-Specific Cognitive Training Regimen

In recent years, much emphasis has been placed on the domain of cognitive training as a potential non-pharmacological intervention for delaying cognitive decline, especially due to findings that the brain is capable of plasticity up to very old age. However, past studies have yet to consider individual differences in participants when assigning training regiments. Jacob will administer cognitive assessments and analyze participant data, hoping to uncover how the personalization of cognitive training can help to maximize gains and how we can best delay the onset of cognitive decline in older adults.

Tara Shelby, Electrical Engineering

Mentor: William Talbot, Developmental Biology

Analyzing the Effects of Knocking Out the Ceramide Synthase Gene on Zebrafish Myelination

Ceramide is an essential messenger of a pathway that involves apoptosis and growth arrest, and is also an essential component in building the myelin sheath around nerve fibers. Tara will analyze the effects that knocking out the ceramide synthase gene, which is critical in ceramide synthesis, has on myelination of the axons in the central nervous system of zebrafish. She will generate fish with an inactive form of this gene and, with live imaging, determine the number of myelin producing cells, the timing of development, and where myelination does or does not occur. This research could shed light on diseases like multiple sclerosis.

"I felt like I gained some valuable lab experience that isn't necessarily exposed in a class-lab setting or in my previous research through the Bio department. Working on a distinct project that was my own (and not just working on running experiments for a mentor's project) relies on a lot of skills beside experimentation and technique."

—USRP Participant Lana Ho

Sierra Porter, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Marion Buckwalter's lab

Tyler Shibata, Chemistry
Mentor: Gerlinde Wernig, Pathology
Modeling Desmoid-Type Fibromatosis in Mice
Desmoid-type fibromatosis is a devastating low-grade soft tissue malignancy which infiltrates the surrounding connective tissue. Tyler will be analyzing β-catenin, one of the known molecular drivers of desmoid-type fibromatosis, and its relation to c-Jun, a protein which plays a crucial role in tumor development, using a c-Jun induced mouse model. This work will determine whether c-Jun and its mouse model can be used as a new and valuable tool for research as well as for patients and physicians.

Rahul Shiv, undeclared
Mentor: Julia Kaltschmidt, Neurosurgery
Role of Transcription Factor ETV1 in Gastrointestinal Motility and Colonic Peristalsis
The human body's second brain, the enteric nervous system (ENS), is an autonomic nervous system that orchestrates digestive processes—especially peristalsis, the movement of the bowel. Rahul will study the impact of transcription factor ETV1 on impairment of peristalsis in mice mutants. He will use a gastrointestinal motility monitor to quantify differences in peristalsis between the colon tissues of new mouse strains in which ETV1 is deleted from specific ENS cell types, thus exploring the contributions of specific ETV-expressing cell populations to overall ENS function.

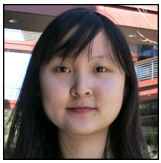
Anika Sinha, Human Biology
Mentor: David Yeomans, Anesthesiology, Perioperative & Pain Medicine
Analysis of NFKB Activity in a Rat Model of Opioid-Induced Hyperalgesia
NF-kB is a transcription factor involved in facilitating pain; however, not much is understood regarding its role in developing analgesic tolerance induced by opioids, such as fentanyl. Anika's project utilizes a fentanyl-based rat model that mimics enhanced responsiveness to painful stimulation in order to study changes in NF-kB activity in the brain. This will help better understand how opioid addiction can induce increased pain sensitivity.

Walter Sobba, Human Biology

Mentor: Calvin Kuo, Medicine (Hematology)

Drug Screening and Identification of Synthetic Lethalities for ARID1A Mutated Gastric Cancer

Mutations in a gene called ARID1A, which is part of a specific chromatin remodeling complex subunit and normally acts as a tumor suppressor, are present in 29% of gastric cancers and 7% of all cancers. Walter's project plans to use human gastric organoids to perform a drug screen of more than 2,000 compounds. Identified compounds will then be investigated in order to characterize the causative pathway, which will pave the way for future research in developing synthetic lethalities for ARID1A mutation.

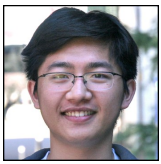


Joanna Song, Bioengineering

Mentor: Markus Covert, Bioengineering

Studying Metabolic Changes in Single Activated Macrophages During an Immune Response

Pro-inflammatory macrophage cells fight infection in the body and experience drastic metabolic changes when doing so. HIF-1$^{\alpha}$, a subunit of a genetic transcription factor, is required to achieve these changes, which include an increase in glycolysis, the enzymatic breakdown of glucose. However, HIF-1$^{\alpha}$'s effects on metabolism in a single cell are not well-studied. In order to get a more comprehensive understanding of HIF-1$^{\alpha}$'s role in helping to launch an immune response, Joanna will combine molecular biology techniques and live-cell microscopy to study how HIF-1$^{\alpha}$ regulates changes in the rate of glycolysis in single pro-inflammatory macrophages.

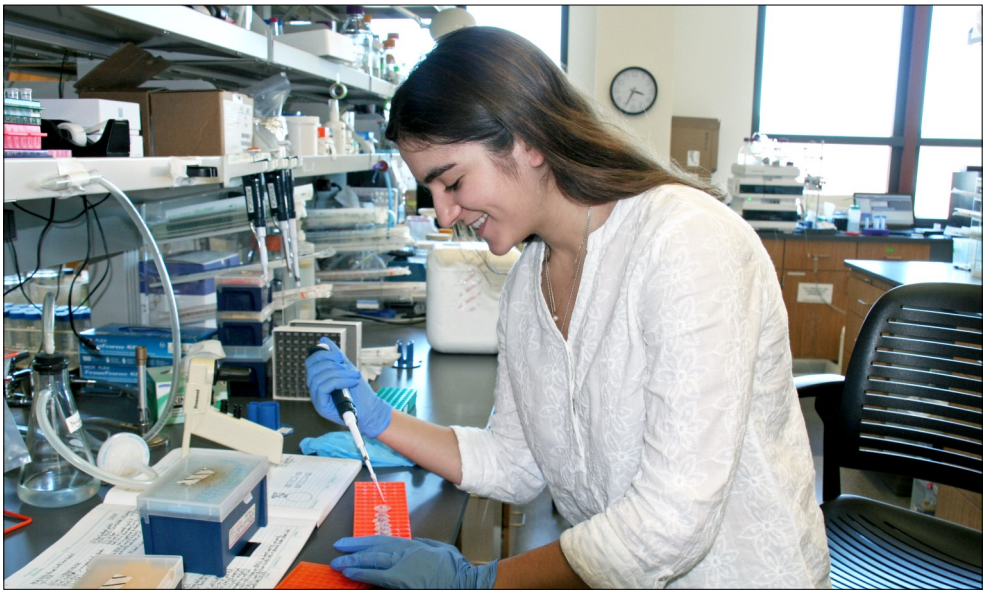


Stephen Su, Biomedical Computation

Mentor: Le Cong, Pathology and Genetics

Re-Engineering a New Class of CRISPR-Cas Proteins to Create a Universal RNA-Protein Interrogation Technology

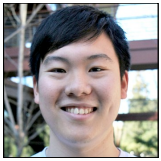
Stephen's project will focus on developing new techniques for studying RNA protein interactions with CRISPR/Cas technology. RNA binding proteins (RBPs) regulate structure, localization, and function of both coding and non-coding RNAs. The precise elucidation of these interactions would provide insight into diseases associated with problems in RBP expression, such as neuropathies, muscular atrophies, metabolic disorders, and cancer.



Jessica Frank, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Jennifer Cochran's lab

Jerry Sun, Chemical Engineering

Mentor: Tony Wyss-Coray, Neurology & Neurological Sciences



Elucidation of a Mechanism for CD22-Mediated Inhibition of Phagocytosis in Microglia

Microglia are the resident immune cells of the brain and are responsible for maintaining homeostasis in the central nervous system by various means, including phagocytosis, or ingestion, of pathogens and cellular debris. With age and in neurodegenerative diseases, the ability of microglia to phagocytose decreases, and this change is associated with a decline in cognitive abilities. Jerry's project interrogates the role of the CD22 gene on the impairment of microglial phagocytic capacity, with the aim of uncovering potential targets to restore microglial phagocytosis as a therapeutic strategy in age-related neurodegenerative disease.

Colton Swingle, Bioengineering

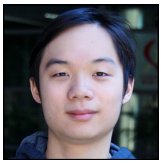
Mentor: Jin Hyung Lee, Neurology & Neurological Sciences, Neurosurgery, and Bioengineering

Systems-Level Brain Circuit Manipulation

Current neuroimaging technologies can model brain structure but lack the capability to reveal neural circuit functions. The development of new imaging techniques such as optogenetic fMRI combines genomic expression with neural imaging to model the dynamic function of neural circuits. This research leads to more noninvasive methods for understanding brain function, and application of circuit imaging to diseases such as Parkinson's and Alzheimer's. Colton will be working to develop a technique to model brain function with sonic imaging in real time, allowing the subject to stay conscious and mobile, to understand the connection between action and neural function.

Mingqian Tan, Biology

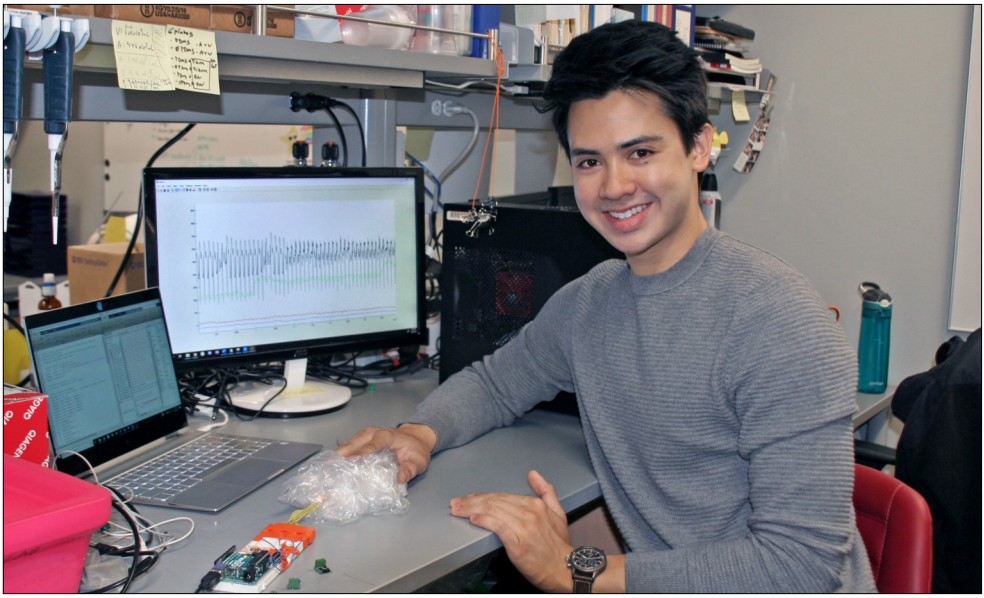
Mentor: Christin Kuo, Pediatrics (Pulmonary Medicine)



Identifying and Characterizing Developmental Signals in Pulmonary Neurosensory Organ Formation

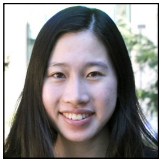
Pulmonary neuroendocrine cells (PNEC) have been identified as the primary cell of origin for small-cell lung cancer (SCLC). Little is known about the molecular mechanisms that underlie this; a better understanding will help us develop new SCLC treatments. Mingqian's research aims to functionally characterize a subset of PNEC progenitors that he identified, and to determine how this pathway, along with other candidate signaling pathways, is involved in PNEC development.

Rahul Shiv, 2019 cohort, completed his Stanford Bio-X summer research training in Dr. Julia Kaltschmidt's lab



Cody Carlton, 2019 student mentor, completed his Stanford Bio-X summer research training in Dr. Anson Lee's lab

Ella Tessier-Lavigne, Symbolic Systems
Mentor: Jennifer Raymond, Neurobiology
Tuning the Oculomotor Integrator in Mice Through Behavioral Training
Neural computations involved in a number of processes, including sensation and cognition, rely on the dynamics of large, recurrently connected populations of neurons. Ella's project aims to look at the oculomotor system—which involves signals encoding desired eye velocity as a way to produce new eye position signals—as a model for how these computations are adaptively modified by experience to "tune" and improve the performance of the systems involved. To do so, she will develop a new behavioral training protocol in mice to tune the oculomotor integrator, in order to investigate the relevant neural circuitry and better understand how this process happens.



Emma Tsai, Human Biology
Mentor: Joseph Wu, Medicine (Cardiovascular Medicine) and Radiology
Modeling the Effects of SGLT2 Inhibitors on Endothelial Inflammation in Diabetes
Sodium-glucose cotransporter 2 (SGLT2) inhibitors are a promising class of diabetes medications that have been shown to improve the vascular outcomes of patients with type 2 diabetes mellitus. The mechanisms by which these medications improve vascular endpoints are not known. Emma's project will use patient-specific stem cell-derived endothelial cells to investigate the potential of these inhibitors in reducing endothelial inflammation, a possible mechanism for why diabetic patients treated with these medications have improved vascular outcomes.

David Vacek, undeclared
Mentor: Liqun Luo, Biology
Transcriptional Mechanisms that Coordinate Physiology and Connectivity in *Drosophila* Olfactory Neurons
The function of a neuron is determined both by its physiology and connectivity, but the transcriptional regulatory mechanisms that coordinate these two features are poorly understood. David will perform a genetic study using the *Drosophila* model to discover important transcription factors and then find their mechanism in coordinating receptor expression and wiring specificity.

Maya Varma, **Computer Science**

Mentor: Dennis Wall, Pediatrics (System Medicine) and Biomedical Data Science

Machine Learning and Graph Clustering Algorithms for Identification of Single Nucleotide Variants Associated with Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social impairments, communication difficulties, and restricted and repetitive patterns of behavior. ASD is a genetically complex disorder, but the contribution of noncoding DNA regions to ASD susceptibility remains unclear. Maya is developing a machine learning approach for identifying variants in the noncoding genome that are potentially linked with the ASD phenotype, with the goal of better understanding the genetic development of ASD.

Grace Wang, **undeclared**

Mentor: Nirao Shah, Psychiatry & Behavioral Sciences and Neurobiology

Molecular Representation of Sex in the Brain

Male and female animals possess innate differences in social behaviors that are developmentally wired. These differences reflect the actions of a sexually dimorphic brain, driven in large part by sex hormones such as estrogen and testosterone. Grace's research aims to identify and understand how sex-specific receptor action may lead to sex-specific gene expression and subsequent sexual dimorphisms in development, circuit function, and behavior.

Marlon Washington II, **Bioengineering**

Mentor: Andrew Huberman, Neurobiology and Ophthalmology

Finding Markers of Human Stress Responses through Virtual Reality Using Objective Physiological Measurements

Vision is a strong model for addressing the adaptiveness of behaviors and autonomic arousal. By gaining data from an established virtual reality environment that reliably evokes physiological and behavioral responses to the virtual presentation of heights, Marion's goal is to formulate a function of human baseline arousal that can predict human defensive responses to heights. By applying the same function to the data from subjects with anxiety disorders, we can gain a quantitative understanding of human mental disorders.

Daniel Wu, **undeclared**

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

Leveraging Large Datasets to Assess Cardiovascular Health: Designing Algorithmic Risk Scores for My Heart Counts 3.0

My Heart Counts is a widely distributed iOS app, developed by the Ashley lab, for cardiovascular health research and intervention. This app has produced a vast amount of lifestyle, health, and gait data, which holds great potential to inform health diagnostics and interventional tools. To this end, Daniel will work on building machine learning models to infer cardiovascular disease risk from gait accelerometry and to produce widely distributable methods for creating individualized cardiovascular risk scores, in order to advance the field of personalized medicine.

Emily Yang, **Biology**

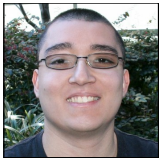
Mentor: Carolyn Bertozzi, Chemistry

Identifying Bacterial Proteases for the Characterization of MUC16 and its Role in Ovarian Cancer

Protein glycosylation patterns in cancerous cells are uniquely different from normal, healthy cells. Emily will be focusing on MUC16, a glycoprotein that is a standard biomarker for ovarian cancer and is secreted into the bloodstreams of patients. She will be purifying enzymes that can selectively cleave glycoproteins into smaller fragments, facilitating mass spectrometry analysis to better map out the structure of specific glycoproteins and analyze their roles in cancer progression.

2019 Stanford Bio-X Undergraduate Summer Research Program Student Mentors:

Cody Carlton, Computational Biology
Mentor: Anson Lee, Cardiothoracic Surgery
A Novel Patient-Specific Electrode for Mapping Atrial Fibrillation
The goal of Cody's research is to develop a novel surgical tool that can precisely identify and treat sites of arrhythmia in patients. This surgical tool will be used to guide treatment of atrial fibrillation in order to reduce the debilitating occurrence of these dangerous heart rhythms.



Jorge Delgado, Biology
Mentor: Thomas Anderson, Anesthesiology, Perioperative & Pain Medicine
Utilizing Focused Ultrasound Neuromodulation for Persistent and Reversible Blockade of Rat Nerve Fibers in the Study of Decreasing Pain
Focused ultrasound (FUS) neuromodulation has the potential to safely and non-pharmacologically decrease acute pain and the degree of and risk for the development of chronic postoperative pain. The specific aim of Jorge's project is to optimize focused ultrasound parameters for persistent and reversible blockade of all nerve fibers in an *ex vivo* rat sciatic nerve model.

Anaïs Tsai, Biology
Mentor: Tim Stearns, Biology and Genetics
Harnessing the Hedgehog Hotline: Investigating Hedgehog-Dependent Proliferation in Medulloblastoma
Primary cilia are antenna-like signaling organelles present in most human cells. Cilia control cell proliferation through the Hedgehog signaling pathway. Disruption of the signaling function of cilia in brain cells is the cause of medulloblastoma, the most common childhood brain cancer. Anaïs will bring together cell biology and genetic approaches to investigate how cilium-based signals control proliferation and differentiation, with the long-term goal of informing the development of therapeutics for ciliary signaling diseases such as medulloblastoma.

Panayiotis Vandris, Biology and Comparative Literature
Mentor: Crystal Mackall, Pediatrics (Hematology & Oncology) and Medicine (Blood & Marrow Transplantation)
Ameliorating Exhaustion to Enhance Efficacy of CAR T Cell Therapy
CAR T cell therapy has shown promise in the treatment of B cell malignancies, but the adoption of CAR T cell therapy as a standard of care for a wider range of cancer types is limited by factors including T cell exhaustion. Panos's project will use synthetic biology approaches to assess a tunable CAR system that is resistant to exhaustion. A mechanistic understanding of exhaustion and the application of engineering principles to CAR T cell design will promote the translational potential of adoptive immunotherapy for cancer.

Posters Presented by 2019 Cohort on August 29, 2019

"Characterizing Neural Activity in the ALM and Medulla"
Nic Becker[1], Shaul Druckmann[2,3]
Departments of Physics[1], Neurobiology[2], and Psychiatry & Behavioral Sciences[3], Stanford University

"How Are Neurons Assembled? Exploring the Molecular Mechanisms of Nemitin, a Novel Microtubule Organizing Protein"
Brandon Bergsneider[1], Ivan Millan[1], Yanmin Yang[1]
Department of Neurology & Neurological Sciences[1], Stanford University

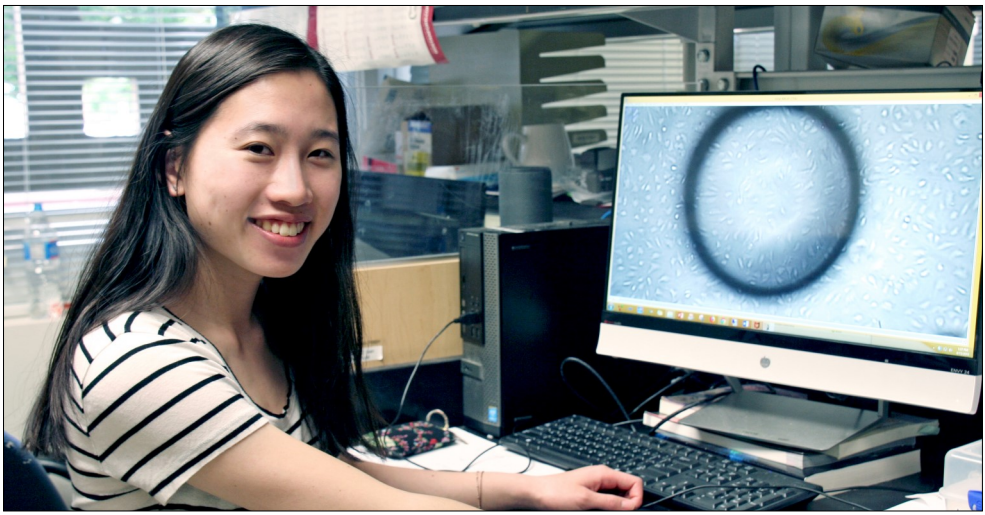
"Connecting Single-Sarcomere Dynamics with Contractile Force Production in DMD hiPSC-CMs"
Foster Birnbaum[1], Gaspard Pardon[1], Helen Blau[1]
Department of Microbiology & Immunology[1], Stanford University

"Multiple Overlapping Hypothalamus-Brainstem Circuits Drive Rapid Threat Avoidance"
Susanna Bradbury[1,2], Matthew Lovett-Barron[1,2], Ritchie Chen[1,2], Karl Deisseroth[1,2,3,4]
Departments of Bioengineering[1] and Psychiatry & Behavioral Sciences[3], CNC Program[2], and Howard Hughes Medical Institute[4], Stanford University

"Light Up the Labyrinth: Creating Map for Forelimb Motor Neuron Circuits in Immunodeficient Rats"
Xiangmeng Cai[1], Vanessa Doulames[2], David Altman[2], Dean Tran[2], Giles W. Plant[2]
Departments of Bioengineering[1] and Neurosurgery[2], Stanford University

"Sulfate-Reducing Bacteria and Gut Inflammation in Bangladeshi Children"
Rebecca Christensen[1], Jessica Grembi[2], Alfred Spormann[2]
Departments of Biology[1] and Civil & Environmental Engineering[2], Stanford University

"Investigating the Immunological Structure and Composition of Tuberculosis Granulomas with Multiplexed Ion Beam Imaging"
Alea Delmastro[1,2], Erin McCaffrey[3,4], Joshua Mattila[5], Noah Greenwald[3], Leeat Keren[3], Michael Angelo[3]
Departments of Chemical Engineering[1] and Pathology[3], Stanford Bio-X Undergraduate Summer Research Program[2], and Immunology Program[4], Stanford University; Department of Infectious Diseases & Microbiology[5], University of Pittsburgh



Emma Tsai, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Joseph Wu's lab

2016 Stanford Bio-X Undergraduate Summer Research Program (USRP) Participants

"Making Mosquitoes the New Grunt Pipetters: Rapid Polling of Vector-Pathogen Ecology"
Clayton Ellington[1], Shailabh Kumar[1], Felix Hol[1], Manu Prakash[1]
Department of Bioengineering[1], Stanford University

"Multiplexed Autoantibody Profiling of Idiopathic Multicentric Castleman Disease (iMCD)"
Allan Feng[1], Tea Dodig-Crnkovic[2], Sarah Chang[1], Jochen Schwenk[2], David Fajgenbaum[3], Paul J. Utz[1]
Department of Medicine[1], Stanford University; KTH Royal Institute of Technology[2], Stockholm; Perelman School of Medicine[3], University of Pennsylvania

"Suppressing Huntingtin Aggregation Through the Directed Evolution of ApiCCT1"
Anthony Flores[1], T. Kelly Rainbolt[1], Judith Frydman[1]
Department of Biology[1], Stanford University

"Crystallization of a Novel Immune Checkpoint Protein"
Jessica Frank[1], Jack Silberstein[1,2], Daniel Fernandez[3], Jennifer Cochran[1,2]
Department of Bioengineering[1], Program in Immunology[2], and ChEM-H Macromolecular Structure Knowledge Center[3], Stanford University

"Understanding the Mechanism of Smoothened Activation in Hedgehog Signaling through Directed Mutagenesis"
Sara Frigui[1], Maia Kinnebrew[1], Rajat Rohatgi[1]
Department of Biochemistry[1], Stanford University

"Determining the Effect of Maternal Immune Activation on Priming Microglial Responses"
Catherine Gao[1], Jennifer Su[1], Theo Palmer[1]
Department of Neurosurgery[1], Stanford University

"Air Pollution, Cellular Aging, and Stress Biology in Adolescents: The Role of Familial Risk for Depression"
Julia S. Gillette[1], Jonas G. Miller[1], Ian H. Gotlib[1]
Stanford Neurodevelopment, Affect & Psychopathology Laboratory[1], Stanford University

2017 Undergraduate Summer Research Program (USRP) Participants

"Loss of Adaptive Myelination Contributes to Methotrexate Chemotherapy-Related Cognitive Impairment"
Jacob Greene[1,2], Anna C. Geraghty[1,2], Erin M. Gibson[1], Reem A. Ghanem[1], Alfonso Ocampo[1], Andrea K. Goldstein[1], Lijun Ni[1], Tao Yang[1], Rebecca M. Marton[2,3], Sergiu P. Pasca[2,3], Michael E. Greenberg[4], Frank M. Longo[1,2], Michelle Monje[1,3,5,6,7]
Departments of Neurology & Neurological Sciences[1], Psychiatry & Behavioral Sciences[3], Pathology[5], and Pediatrics[6], Stanford Bio-X[2], and Institute for Stem Cell Biology & Regenerative Medicine[7], Stanford University; Department of Neurobiology[4], Harvard Medical School

"The Nuclear Option: Regulation of the Nuclear Lamina in Tumor Evolution"
Sierra Ha[1], Amar Mirza[1], Siegen McKellar[1], Fernanda Gonzalez[1], Anthony Oro[1]
Department of Dermatology (Program in Epithelial Biology)[1], Stanford University

"*In situ* Barcode Sequencing for Pooled CRISPR Screens"
Cynthia Hao[1], Adrian Sanborn[2,3], Lorenzo Labitigan[4,5], Julie Theriot[5], Roger Kornberg[2]
Departments of Bioengineering[1], Structural Biology[2,] Computer Science[3], and Biochemistry[4], Stanford University; Department of Biology[5], University of Washington

"Engineering Cyanobacteria to Synthesize and Produce Stromal Cell Derived Factor 1-alpha"
Maria Paula Hernandez[1], Kevin James Jaatinen[2,3], Hanjay Wang[2,3], Joseph Woo[2,3]
Departments of Bioengineering[1] and Cardiothoracic Surgery[2] and Stanford Advanced Therapeutics for Heart Failure Research Laboratory[3], Stanford University

"Using Nanopore Long-Read Sequencing to Investigate Cryptic Adaptation"
Sam Hoelscher[1], Gavin Sherlock[1]
Department of Genetics[1], Stanford University

"Extending LitGen: Incorporating Expert Knowledge for Literature Curation"
Emily Huang[1], Julia Gimbernat[1], Allen Nie[1], Carlos Bustamante[1]
Department of Biomedical Data Science[1], Stanford University

"The Dark Side of the Brain: Defining the Molecular Mechanisms Underlying Neurofibromatosis 1 - Optic Pathway Gliomas"
Jared Hysinger[1], Yuan Pan[2], Nicki Schindler[3], James Lennon[2], Anitha Ponnuswami[2], Xiaofan Guo[4], Yu Ma[4], Courtney Corman[4], David Gutmann[4], Michelle Monje[2]
Departments of Biology[1], Neurology[2], and Human Biology[3], Stanford University; Department of Neurology[4], Washington University

"New Genetic Tools Reveal Dynamic Populations of Transitioning Cells During *Drosophila* Intestinal Homeostasis"
Andrew Labott[1], Erin Sanders[1,2], Lucy O'Brien[1]
Departments of Molecular & Cellular Physiology[1] and Developmental Biology[2], Stanford University

"Ciliary INVS Is Oxygen Sensitive Independent of the NEK8-ANKS6 Complex"
Tracy Lang[1], Henrietta Bennett[1], Timothy Klasson[2], Peter Jackson[1]
Departments of Microbiology & Immunology[1] and Radiation Oncology[2], Stanford University

"Dendritic Spine Density in an Alzheimer's Mouse Model"
Kate LeBlanc[1], Michelle Drews[1], Carla Shatz[1,2]
Departments of Biology[1] and Neurobiology[2], Stanford University

"A Foundation for Massively Parallel Precise Genome Editing in Human Cells"
Jiwoo Lee[1], Shi-An Chen[1], Xiaoshu Xu[2], Stanley Lei Qi[2], Hunter Fraser[1]
Departments of Biology[1] and Bioengineering[2], Stanford University

"Adrenaline Rush: Characterizing Noradrenaline Expression in the Prefrontal Cortex"
Max Lee[1], Adrienne Mueller[1], Tirin Moore[1]
Department of Neurobiology[1], Stanford University

"Seeing with a Meaning: Functional MRI Mapping of Social Gaze Features under Dynamic Visual Stimuli in the Common Marmoset"
Andrew Tong Li[1], Nicholas Alexander Tran[1], Nikola Todorov Markov[1], Keren Haroush[1]
Department of Neurobiology[1], Stanford University

"Assessing Dimensionality Reduction Techniques Downstream of Coupled Clustering on Single Cell Genomic Data"
Miranda Li[1], Zhana Duren[1], Wing H. Wong[1]
Department of Statistics[1], Stanford University

"Ground-Stage Development of a Cellular Vaccine for Liver-Stage Malarial Infection"
Matthew Liao[1,2], Rodolfo Vicetti Miguel[1], Nirk Quispe Calla[1], Kristen Aceves[1], Thomas Cherpes[1]
Department of Comparative Medicine[1] and Stanford Bio-X[2], Stanford University

"Characterizing Cell-Type Dependent IRES Activity of circRNAs Using a High-Throughput Library Screening Method"
Fan Liu[1,2], Chun-Kan Chen[1,2], Howard Y. Chang[1,2]
Departments of Dermatology[1] and Genetics[2], Stanford University

"Synthetic Efforts Toward 10-Saxitoxinethanoic Acid"
Jay Liu[1,2], Holly Hajare[1], Justin Du Bois[1]
Departments of Chemistry[1] and Computer Science[2], Stanford University

"Applying CRISPR Tools to Engineer Parallel Logic Gates in Mammalian Cells"
Kasey Love[1], Hannah R. Kempton[1], Laine Goudy[1], Stanley Lei Qi[1,2,3]
Departments of Bioengineering[1] and Chemical & Systems Biology[2] and ChEM-H[3], Stanford University

"Combating High Grade Serous Ovarian Cancer: Identifying Drug Combinations to Target and Destroy Carboplatin-Resistant VMH Cells"
Alexis Lowber[1,2], Ying-Wen Huang[1,2], Jacob Bedia[1,2], Alyssa Mike[1,2], Veronica D. Muñoz[3], Wendy J. Fantl[1,2]
Departments of Urology[1], Obstetrics & Gynecology[2], and Microbiology & Immunology[3], Stanford University

2015 Stanford Bio-X Undergraduate Summer Research Program (USRP) Participants

"Identifying Molecular Biomarkers of Acute Respiratory Distress Syndrome (ARDS) Through Desorption Ionization Mass Spectrometry and Machine Learning"
Rohan Mehrotra[1], Zhenpeng Zhou[1, 2], Angela Rogers[3], Richard N. Zare[1]
Departments of Chemistry[1] and Medicine (Pulmonary & Critical Care Division)[3], Stanford University; Facebook, Inc.[3]

"A Bioengineered 3D Model of Osteosarcoma Using Gelatin-Based Microribbon Scaffolds"
Omeed Miraftab-Salo[1], Eva C. González Díaz[1], Fan Yang[1,2]
Departments of Bioengineering[1] and Orthopaedic Surgery[2], Stanford University

"Elucidating the Role of ARMCX3 in Synaptogenesis"
Stephen Moye[1], Louise Giam[2], Thomas Südhof[2]
Departments of Bioengineering[1] and Molecular & Cellular Physiology[2], Stanford University

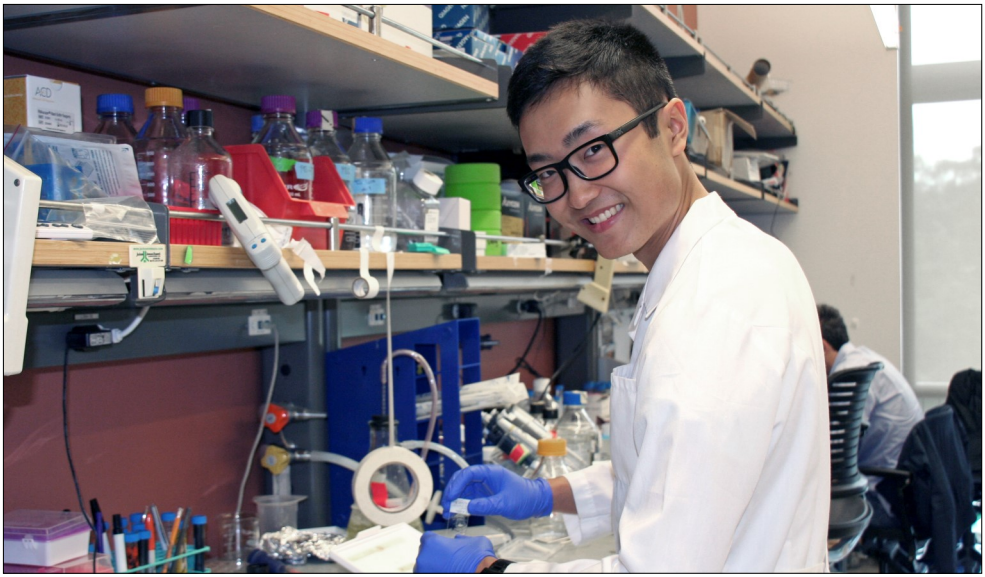
"Single Cell Viral Infection Profiling of Venezuelan Equine Encephalitis Virus"
Avery Muniz[1], Sathish Kumar[2,3], Zhiyuan Yao[2,3], Sirle Saul[2,3], and Shirit Einav[2,3]
Departments of Biology[1], Medicine (Division of Infectious Diseases and Geographic Medicine)[2], and Microbiology & Immunology[3], Stanford University

"c-Jun Amplifies the Pro-Osteogenic Potential of Osteoprogenitors Through Increased Hedgehog- and Wnt-Signaling"
Claire Muscat[1], Tristan Lerbs[1], Camille van Neste[1], Pablo Domizi[1], Yong-Hun Kim[1], Alexa Vu[1], Charles K. Chan[2], Gerlinde Wernig[1,2]
Department of Pathology[1] and Institute for Stem Cell Biology & Regenerative Medicine[2], Stanford University

"The Functional Role of Amygdala-Dopamine Interactions in Motivated Behaviors"
Elizabeth E. Steinberg[1,2], Felicity Gore[1,2,3,4], Madison D. Taylor[1,2], Zane C. Norville[1,2], Talia N. Lerner[2,3,4,5], Karl Deisseroth[2,3,4], Robert C. Malenka[1,2]
Departments of Psychiatry & Behavioral Sciences[2] and Bioengineering[4], Nancy Pritzker Laboratory[1], and HHMI[3], Stanford University; Department of Physiology[5], Northwestern University

"Profiling the Inflammasome Assembly Time Course after dMCAO Stroke"
Sierra Porter[1], Victoria Hernandez[1], Marion Buckwalter[1]
Department of Neurology & Neurological Sciences[1], Stanford University

"Investigating the Effects of Hormone Treatment on Cognition, Behavior, and Neurodevelopment in Transgender Youth"
Bobby Radecki[1], Maureen Gil[1], Sharon Bade Shrestha[1], Iliana Karipidis[1], David Hong[1]
Department of Psychiatry & Behavioral Sciences (Center for Interdisciplinary Brain Science Research)[1], Stanford University



Tyler Shibata, 2019 cohort, completed his Stanford Bio-X summer research training in Dr. Gerlinde Wernig's lab

"Exploring Innate Immune Cell Responses to Dengue Virus"
John Rees[1], Laura Simpson[2], Catherine Blish[2]
Departments of Biology[1] and Medicine (Infectious Diseases)[2], Stanford University

"Investigating Cell Composition Differences in Human Cortical Spheroids Derived from 22q11 Deletion Syndrome Patients"
Julia M. Schaepe[1,2], Themasap A. Khan[1,2], Sergiu P. Pasca[1,2]
Department of Psychiatry & Behavioral Sciences[1] and Stanford Human Brain Organogenesis Program[2], Stanford University

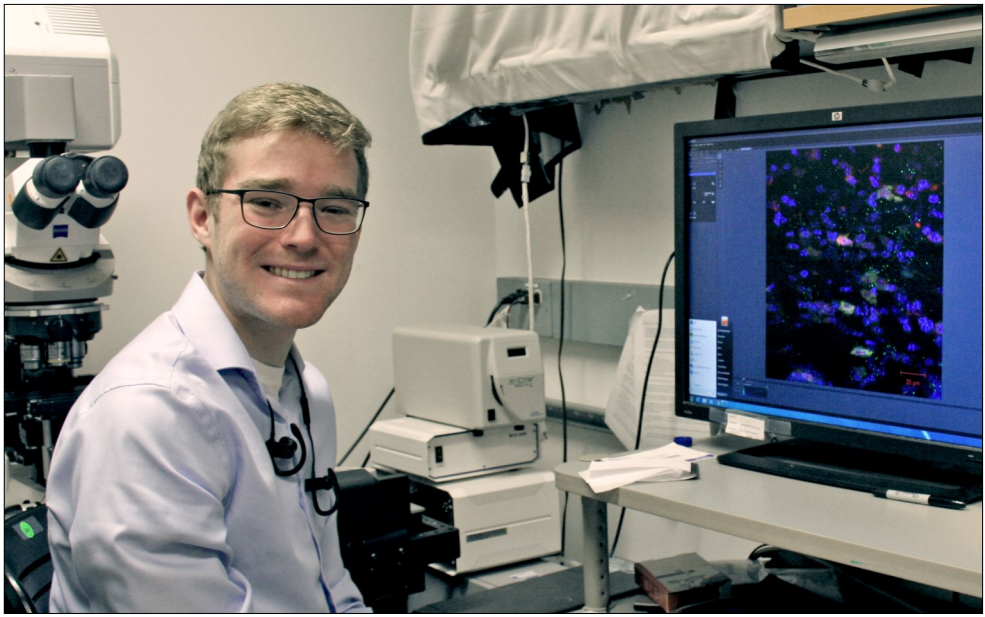
"Cell-Type Specific Subcellular Organization of Delta and Mu Opioid Receptors"
Ethan Schonfeld[1], William McCallum[2,3,4,5], Gregory Scherrer[2,3,4,5,6]
School of Humanities & Sciences[1], Departments of Anesthesiology, Perioperative & Pain Medicine[2], Molecular & Cellular Physiology[3], and Neurosurgery[4], Wu Tsai Neurosciences Institute[5], and New York Stem Cell Foundation – Robertson Investigator[6], Stanford University

"The Effect of Baseline Ability and Age on Improvements in a Specialized Skill-Specific Cognitive Training Regimen"
Jacob Shaw[1], Hannah Fingerhut[1], Lindsay Chromik[1], S.M. Hadi Hosseini[1]
Department of Psychiatry & Behavioral Sciences[1], Stanford University

"The Role of Ceramide Synthesis in Regulating Myelination in Zebrafish"
Tara Shelby[1], Ellen Bouchard[1], William Talbot[1]
Department of Developmental Biology[1], Stanford University

"c-Jun Drives Scleroderma through Increased Hedgehog Signaling"
Tyler Shibata[1]*, Tristan Lerbs[1]*, Lu Cui[1], Tim Chai[2], Claire Muscat[1], Gerlinde Wernig[1,2]
(*equal contribution) Department of Pathology[1] and Institute for Stem Cell Biology & Regenerative Medicine[2], Stanford University

"Making (Peristaltic) Waves: Exploring the Enteric Nervous System Using an *ex vivo* Gastrointestinal Motility Monitor"
Rahul Shiv[1], Subhamoy Das[1], Estelle Spear[2], Grant Hennig[3], Aida Habtezion[2], Julia Kaltschmidt[1,4]
Departments of Neurosurgery[1] and Gastroenterology[2] and Wu Tsai Neurosciences Institute[4], Stanford University; Department of Pharmacology[3], University of Vermont



Jacob Greene, 2019 cohort, completed his Stanford Bio-X summer research training in Dr. Michelle Monje's lab

"Developing an Opioid-Induced Hyperalgesic Rat Model for NF-κB Activation Studies"
Anika Sinha[1], Mikhail Klukinov[1], Eunjoo Choi[1], David C. Yeomans[1]
Department of Anesthesiology[1], Stanford University

"Investigating the Dynamics of HIF-1a Activation in Response to Immune Stimuli"
Joanna Song[1], Stevan Jeknić[1], Markus W Covert[1]
Department of Bioengineering[1], Stanford University

"Dissecting the RNA Interactome"
Stephen Su[1], Jason Cheng[1], Le Cong[1,2]
Departments of Genetics[1] and Pathology[2], Stanford University

"Genetic and Proteomic Ligand Discovery for CD22, a Microglial Homeostasis Regulator"
Jerry Sun[1,2], John V. Pluvinage[1,3,4], Michael S. Haney[1], Ryan A. Flynn[5], Carolyn R. Bertozzi[5,6,7,8], Tony Wyss-Coray[1,7,9,10,11]
Departments of Neurology & Neurological Sciences[1], Chemical Engineering[2], Chemistry[5], and Chemical & Systems Biology[6], Medical Scientist Training Program[3], Stem Cell Biology & Regenerative Medicine Graduate Program[4], ChEM-H[7], Paul F. Glenn Center for the Biology of Aging[10], and Wu Tsai Neurosciences Institute[11], Stanford University; Howard Hughes Medical Institute[8]; VA Palo Alto Health Care System[9]

"Developing an Image Recognition Atlas for Optogenetic Functional Ultrasound Imaging of the Brain in Awake and Behaving Mice"
Colton Swingle[1], Brad Edelman[2], Giovanna Diletta Ielacqua[2], Jin Hyung Lee[1,2,3,4]
Departments of Bioengineering[1], Neurology & Neurological Sciences[2], Neurosurgery[3], and Electrical Engineering[4], Stanford University

"*In vivo* Temporal Mapping of Proneural Transcription Factors *Ascl1* and *Myt1* During Embryonic Pulmonary Development"
Mingqian Tan[1], Christin Kuo[1]
Department of Pediatrics[1], Stanford University

"Exploring Small Eye Movements and Adaptive Plasticity in the Mouse Oculomotor Integrator"
Ella Tessier-Lavigne[1], Sriram Jayabal[1], Jennifer Raymond[1]
Department of Neurobiology[1], Stanford University

"The Antenna's All the Difference; How Does Having a Ciliated Centriole Change Centriole Function?"
Anaïs Tsai[1], Emily Ho[2], Tim Stearns[1,3]
Departments of Biology[1], Developmental Biology[2], and Genetics[3], Stanford University

"Determining the Mechanisms by Which SGLT2 Inhibitors Improve Vascular Function in Diabetes"
Emma Tsai[1,2,3], Ian Y. Chen[1,4], Vincent Wo[1,2,3], Huaxiao Yang[1,2,3], Pedro Medina[1,4], Cho-Kai Wu[1,2,3], Chun Liu[1,2,3], Nazish Sayed[1,2,3], Tracy McLaughlin[5], Joseph Wu[1,2,3]
Cardiovascular Institute[1] and Departments of Medicine (Divisions of Cardiovascular Medicine[2] and Endocrinology[5]) and Radiology[3], Stanford University; Medical Service (Cardiology Section)[4], VA Palo Alto Health Care System

"Genetic Mechanisms of Olfactory Receptor Specification During Development in *Drosophila*"
David Vacek[1], Hongjie Li[1], Liqun Luo[1]
Department of Biology[1], Stanford University

"Epigenetic Modulation of CAR T Cell Function"
Panayiotis Vandris[1], Evan W. Weber[1], Crystal L. Mackall[1]
Stanford Cancer Institute[1], Stanford

"Maximum-Flow Formulation Identifies High-Confidence Variants in Simple Repeat Sequences Associated with Autism Spectrum Disorder"
Maya Varma[1], Kelley Paskov[2], Brianna Chrisman[3], Min Woo Sun[2,5], Jae-Yoon Jung[2,5], Nate Stockham[4], Peter Washington[3], Dennis P. Wall[2,5]
Departments of Computer Science[1], Biomedical Data Science[2], Bioengineering[3], Neuroscience[4], and Pediatrics[5], Stanford University

"Visualization and Manipulation of Novel Hypothalamic Sexually Dimorphic Genes"
Grace Wang[1,2], Joe Knoedler[1], Nirao Shah[1,2]
Departments of Psychiatry & Behavioral Sciences[1] and Neurobiology[2], Stanford University

"Finding Markers of Human Stress Responses through Virtual Reality Using Objective Physiological Measurements"
Marlon Joseph Washington II[1], Melis Yilmaz Balban[1], Andrew Huberman[2]
Departments of Neurobiology[1] and Ophthalmology[2], Stanford University

"Demographic Inference from Smartphone Gait Acceleometry: Applying Deep Convolutional Networks to the MyHeartCounts Six-Minute Walk Test"
Daniel Wu[1], Anna Shcherbina[2], Steve Hershman[2], Euan Ashley[2]
Departments of Computer Science[1] and Medicine[2], Stanford University

"An Enzymatic Toolkit for Studying Mucin-Domain Glycoproteins"
Emily Yang[1,2], Judy Shon[2], Stacy A. Malaker[2], Carolyn R. Bertozzi[2,3]
Departments of Biology[1] and Chemistry[2], Stanford University; Howard Hughes Medical Institute[3]

"The most important lesson that I learned was how to critically think about research to develop appropriate questions. Then from the questions I learned how to design experiments that would hopefully address the question… Finally I learned how to implement the experiments I have designed and interpret the results."
—USRP Participant Tally Buckstaff

Stanford Bio-X Undergraduate Summer Research Program

2018 Stanford Bio-X Undergraduate Summer Research Program (USRP) Participant Jan Sokol

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