
STANFORD
BIO-X
UNDERGRADUATE
SUMMER
RESEARCH
PROGRAM 2021

# STANFORD BIO-X
# UNDERGRADUATE SUMMER RESEARCH PROGRAM


2018 Undergraduate Summer Research Program (USRP) Participants

In the summer of 2021, the students involved in the Stanford Bio-X Undergraduate Summer Research Program, along with the Stanford community and beyond, faced unique challenges, with continuously changing research opportunities and policy guidelines to keep our communities safe. Faculty, students, and staff from 38 departments worked together to make the 17th year of the Stanford Bio-X Undergraduate Summer Research Program its first-ever hybrid summer, offering research opportunities to both populations of students, those who are on-campus as well as those who are working remotely. Stanford Bio-X facilitated a vigorous, valuable, and fulfilling in-person *as well as* virtual undergraduate experience, maintaining our commitment to sharpening students' research skills and techniques, whether they were conducting their research in the lab or from a remote location.

Since 2006, the Stanford Bio-X USRP has provided a ten-week summer research opportunity to a total of 783 students to date. We have partnered with 327 Stanford faculty mentors to provide this one-of-a-kind educational opportunity to these passionate young researchers. Our 2021 cohort of 75 students and their respective mentors have adjusted the students' projects so that their research can be conducted in-person, long-distance, or, in some cases, a combination of in-person and virtual.

To keep our community intact and vibrant during these unprecedented times, for the second year during the pandemic, Bio-X once again went above and beyond to incorporate interactive new experiences for the cohort and expanded the program to include 18 postdocs, graduate students, researchers, and senior-level undergraduates to facilitate fulfilling new connections and networks, and to enrich the students' learning experience. Bio-X has sustained the hallmarks of our summer program in a virtual format, so that students can participate in real time regardless of where they are. As always, our weekly faculty talks expose students to the broad range of scientific fields and research that takes place at Stanford and directly introduce them to dozens of Stanford faculty members eager and willing to share their personal academic journeys as well as their research. This year's program culminates with students developing presentations detailing the progress of their summer work, giving them the opportunity to refine their skills at both visual and verbal research presentation.

**Workshops and Wet Lab Technique Talks:**
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. A wet lab technique training series

teaches specific wet lab techniques through weekly group discussions led by experienced researchers, to broaden the students' research knowledge base. In addition to the undergraduate cohort receiving valuable training, by developing these workshops, the graduate students and postdoctoral fellows gain the opportunity to practice their teaching and presentation skills and collaborate with one another on programming content. They also become a resource for the summer cohort for broader career and research advice, expanding the students' network of colleagues at Stanford.

**Journal Clubs:**
A journal club series facilitates critical thinking among the students as they work in small groups and lead intellectually rigorous discussions regarding recent publications, innovations, and challenging scientific problems. Similar to the workshops, these educational programs for the cohort offer postdocs, graduate students, and researchers unique opportunities to develop their teaching skills, share their research insights, improve their mentorship capabilities, and expand their interactions with undergraduate students. At a time marked by changes and uncertainty, we are delighted to offer these researchers a chance to become a part of the USRP program and Bio-X family, enhancing their own career development as well as the student cohort's summer experience.

**Peer Share Meetings:**
Bio-X also provides additional opportunities for the undergraduate students to discuss their progress with one another and the Bio-X team. Peer share meetings encourage the cohort to share ideas and to practice disseminating their research to peers from varying backgrounds, as well as helping them to network with one another.

Our six senior-level undergraduate cohort leads, who have each completed a previous summer of Bio-X USRP training, conduct check-ins and host virtual social events to increase cohort unity and help keep the students connected from across the world. Bio-X remains committed to fostering a strong interdisciplinary training for these up-and coming scientists, and we are excited to use our new and adapted curriculum to ensure that each of our undergrads has a fulfilling summer which enhances their research skills and helps prepare them for future careers in science and medicine.

Funding for the support of our program was provided by generous contributions from The Rose Hills Foundation, Paramitas Foundation, Pitch and Cathie Johnson, Winston Chen and Phyllis Huang, Vicky and David Rogers, Brian and Karen Mariscal in honor of Judy Pinsker-Smith, Stanford Bio-X, and Anonymous Donors.

2015 Undergraduate Summer Research Program (USRP) Participants

# Alumni Comments:

*"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!"*

—2020 USRP Participant Bryanna Godfrey

*"My experience in the Bio-X Undergraduate Summer Research Program last summer definitely helped me to decide to apply to MD/PhD programs... The mentors, graduate students, postdocs, journal clubs, methods talks, faculty talks all showed me that I definitely wanted to continue in research... I am extremely grateful to have had the experience."*

—2020 USRP Participant Daniel Martinez-Krams

*"I participated in BioX during the summer of 2019 [and used] that experience to get a full-time research position in the Ma Lab... My research with Bio-X was a vital component of my application to medical school, and I am very grateful for the support I received from Bio-X throughout that summer."*

—2019 USRP Participant Stephen Moye, now a medical student at Harvard Medical School

*"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."*

—2016 USRP Participant and 2017 Cohort Lead Persiana Saffari, now a medical student at UCLA

*"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

2012 Undergraduate Summer Research Program (USRP) Participants

## Recent Alumni Updates:

*2015 Stanford Bio-X Undergraduate Summer Research Program Participant Kazuomori Lewis in the lab of Dr. Sarah Heilshorn.*

**Jesse Engreitz, 2008 cohort (right)**, began to explore genome regulation research during his summer with Stanford Bio-X. Jesse pursued an MS at Stanford, followed by a PhD through the Harvard-MIT Division of Health Sciences & Technology and postdoctoral training at the Broad Institute. In 2020, Jesse returned to Stanford as an assistant professor of genetics. His lab uses interdisciplinary techniques to try to understand the genetic basis of heart diseases.

**Andrew Chou, 2010 cohort (left)**, is an orthopaedic surgery senior resident at SingHealth and the director for Innovation & Design Thinking at the Duke-NUS Medical School in Singapore. After his Stanford Bio-X summer, Andrew was a Stanford Byers Center for Biodesign Global Innovation Fellow, and his team's medical device won the Disrupt Diabetes Design Challenge in 2018. In addition to awards such as the Stanford Dean of Students Outstanding Achievement Award, the Seah Cheng Siang Gold Medal in Medicine, and an ESCEO-Eli Lilly Healthcare Provider Scholarship, Andrew has contributed to 33 publications.

**Shaughnessy Brown, 2012 cohort (right)**, completed an MS and a PhD in Mechanical Engineering and conducted postdoctoral studies at Stanford, working extensively at SLAC. Her research has been published in *Science Advances*, the *Journal of Synchotron Radiation*, and *Review of Science Instruments*. Shaughnessy is currently a product manager at Google.

**Kazuomori Lewis, 2015 cohort (above, in the lab of Dr. Sarah Heilshorn in 2015)**, is a PhD candidate in Dr. Davis Schaffer's lab as part of the UC Berkeley-UCSF Program in Bioengineering. His research involves using cellular reprogramming strategies to develop regenerative therapies for the central nervous system. Kaz, an avid photographer, is also the staff photographer for the Berkeley Science Review magazine.

**Kristina Correa, 2016 cohort (left)**, began her research career in the lab of Dr. Theo Palmer during her summer with Stanford Bio-X. Kristina received the J.E. Wallace Sterling Award for Scholastic Achievement as well as a 2019 Rhodes Scholarship to cover 3 years of study at the University of Oxford. At Oxford, Kristina is completing a master's of science in statistics.

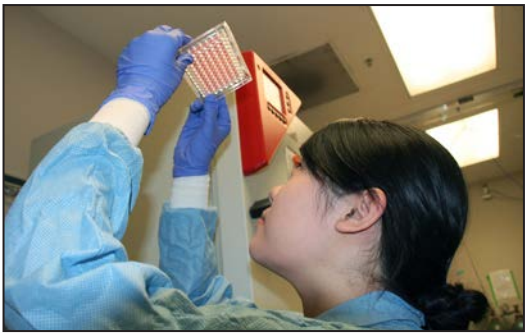
**Rishi Bedi, 2017 cohort (right)**, is the founder of Y-Trap, Inc., a biotechnology company focused on the development of revolutionary technologies for cancer immunotherapy. Y-Trap will be working with Merck to bring their novel platform of targeted multifunctional fusion proteins for cancer immunotherapy to patients. Rishi also founded TreeHacks, Stanford's annual "hackathon" event where student programmers rapidly develop impactful coding projects in 36 hours.

**Alanna Dorsey, 2020 cohort (left)**, recently published her Stanford Bio-X research on the neurobiological and hormonal mechanisms regulating women's sleep in *Frontiers in Neuroscience*. As she continues her undergraduate career, Alanna is also focused on improving science communication and outreach, and works in diversity and inclusion at the startup Flourish All.

# Stanford Bio-X Undergraduate Summer Research Program Alumni:

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

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



*2017 USRP Participant Cindy Liu in Dr. Stephen Skirboll's lab*


2014 Undergraduate Summer Research Program (USRP) Participants

# 2021 FACULTY TALKS FOR THE STANFORD BIO-X UNDERGRADUATE RESEARCH PROGRAM

## June 23

Anna Gloyn (Pediatrics - Endocrinology & Diabetes), "The Genetics of Diabetes: Sweet Dreams & Nightmares"
Craig Levin (Radiology), "High Spatial Resolution Positron Emission Tomography (PET) Imaging Systems Under Development at Stanford"
Sarah Heilshorn (Materials Science & Engineering), "Biomaterials Design for Regenerative Medicine"

## June 30

Anca Pasca (Pediatrics - Neonatal & Developmental Medicine), "Identification of Therapeutic Targets for Brain Injury of Prematurity"
Laramie Duncan (Psychiatry & Behavioral Sciences), "Genetics of Mental Health Conditions"
Marlene Rabinovitch (Pediatrics - Cardiology), "Converging Pathways Inform New Therapies for Pulmonary Arterial Hypertension"

## July 7

Anshul Kundaje (Genetics and Computer Science), "Deep Learning the Regulatory Code of the Human Genome"
Michael Howitt (Pathology and Microbiology & Immunology), "Acquiring a Taste for Parasites: Chemosensory Tuft Cells in Shaping Intestinal Immunity"
Erinn Rankin (Radiation Oncology and Obstetrics & Gynecology), "Targeting the Tumor Microenvironment in Ovarian Cancer"

## July 14

Laura M. K. Dassama (Chemistry), "Chemical Biology for Genetic Blood Disorders"
Thomas Quertermous (Medicine - Cardiovascular Medicine), "Genetic Mechanisms of Coronary Artery Disease"
Emmanuel Mignot (Psychiatry & Behavioral Sciences), "Narcolepsy and the Art of Not Letting Dogs Lie"

## July 21

Ansuman Satpathy (Pathology), "Cancer Immunotherapy and the Next Generation of Cancer Therapies"
Jason Andrews (Medicine - Infectious Diseases), "Tracking the Emergence and Global Spread of Antimicrobial-Resistant Typhoid"
Paul Bollyky (Medicine - Infectious Diseases and Microbiology & Immunology), "Bacteriophage Therapy"

## July 28

Claudia Petritsch (Neurosurgery), "A Journey Across Species: How Studying Cell Fate Decisions in Fly and Mice Led to a Better Understanding of Human Brain Cancer"
Maria Grazia Roncarolo (Pediatrics - Stem Cell Transplantation and Medicine - Blood & Marrow Transplantation), "Genetic Engineering of T Cells for Immune Tolerance"
Henry C. Lee (Pediatrics - Neonatal & Developmental Medicine), "Research and Quality Improvement to Advance Neonatal Health Equity"

## August 4

Kari Nadeau (Medicine and Pediatrics - Allergy & Clinical Immunology), "Signaling Pathways in the Pathogenesis and Treatment of COVID"
Robert M. Waymouth (Chemistry), "New Materials for Gene Delivery: From Chemistry to Biology"
Boris Heifets (Anesthesiology, Perioperative & Pain Medicine), "Deconstructing Powerful Psychotropic Drugs to Make Better Medicine"

## August 11

Wah Chiu (Photon Science Directorate, Bioengineering, and Microbiology & Immunology), "Seeing Molecular Machines by CryoEM"
William Weis (Structural Biology, Photon Science Directorate, and Molecular & Cellular Physiology), "How Do Mechanical Forces Regulate Molecular Functions in Cells and Tissues?"
Katherine Ferrara (Radiology), "Adeno Associated Viruses Deliver to Specific Organ and Cells Subsets"

## August 18

Matthew Wheeler (Medicine - Cardiovascular Medicine), "From One to 8 Billion: Scale and Generalizability in Human Subjects Research"
Casey Gifford (Pediatrics - Cardiology), "Getting to the Heart of the Matter: Complex Genetics and Congenital Heart Disease"
Anthony Wagner (Psychology), "The Cognitive Neuroscience of Remembering"

## August 25

Stephen Quake (Bioengineering and Applied Physics), "The Cell Is a Bag of RNA"
Euan Ashley (Medicine - Cardiovascular Medicine, Genetics, and Biomedical Data Science), "Your Heart Counts"
Chaitan Khosla (Chemical Engineering and Chemistry), "The Chemical Biology of Celiac Disease"

# Workshops on Research Skills:

In 2021, 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 postdocs (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.

## Strategies for Reading, Analyzing, and Organizing Scientific Literature

This workshop covers how to effectively find, read, cite, and organize scientific papers. Aram and Stephan specifically focus on tools readily available to students including Endnote, Papers, PubMed. They also examine published works and discuss helpful strategies to understand the relevant organization of scientific manuscripts.

Dr. Aram Raissi Dr. Stephan Eismann

## Experimental Design Strategies

This workshop gives an introduction to how research projects are designed. Caitlin discusses how to identify your research goal, generate a hypothesis or engineering approach, and how to start designing an experiment to achieve your research goal. This workshop is applicable for both virtual and in-person research.

## Tools and Best Practices for Data Collection and Analysis

In this workshop, Caitlin will discuss data that should be recorded in experiments, 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.

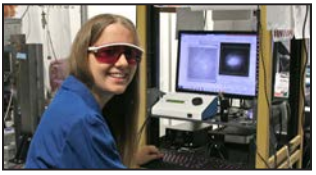
Caitlin Maikawa

## Oral Presentation Skills

Communicating scientific ideas and results in both formal and informal settings are an important part of research. In this workshop, Caitlin and Annina will help students workshop "elevator pitch" style oral presentations for their summer projects, and also discuss oral presentation tips for both poster talks and slide-based presentations.

## Figure Design and Data Visualization

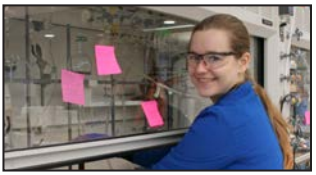
Whether you're trying to explain a general concept to a broad audience or show specific experimental results to your collaborators, you will frequently find yourself wanting to come up with the perfect figure or diagram to help you communicate your science. In this workshop, Annina will discuss how to design great figures, how making different choices with what elements of a dataset you're trying to highlight can focus on a certain message, and share some practical skills for designing Powerpoint Slides to support verbal presentations.



Annina Sartor

## Scientific Writing

In this workshop, Anna will discuss the basics of clear, concise scientific writing. By the end of the session, students will be well-versed in the structure and flow of abstracts, research summaries, and scientific proposals. Participants will also practice describing their research to their peers.



Anna Elleman

# Wet Lab Technique Training Series:

This summer, Stanford Bio-X is also hosting wet lab technique trainings meant to offer background and practical instructions as well as demonstrate specific wet lab skills that will aid students in their future research.

These trainings are followed by interactive group discussions led by research scientists, postdocs, and graduate students (pictured below). Wet lab technique instructors from labs across Stanford, with expertise in the techniques, facilitated in-depth instruction, gain valuable opportunities to hone their teaching skills, and engage in interactive scientific discussions with the undergraduates.

## Additive Manufacturing: From Concept to Prototype



Dr. Brian Lee | Harrison Lin | Dan Somen

Additive manufacturing, also known as 3D printing, accelerates the pace in which researchers can prototype, test, and execute on their ideas. Dr. Joseph DeSimone, the Sanjiv Sam Gambhir Professor of Translational Medicine at Stanford University, will speak on the importance of additive manufacturing in the context of Silicon Valley entrepreneurship. In this training, Brian, Harrison, and Dan will offer an overview of current additive manufacturing technologies, modeling techniques, and emergent research areas in the additive space. Students will learn the advantages and limitations of additive manufacturing by participating in a short interactive modeling workshop showing how to move from a digital file to a physical print.

Dr. Maja Djurisic

## Imaging Cell Structure: A Central Nervous System Example

Cells change their shape in response to constantly changing environment. Modern microscopy offers powerful tools for studying how cells respond to stimuli. In this training, students will learn how to apply fluorescent confocal microscopy to image individual synaptic structures in the central nervous system called dendritic spines. Dendritic spines change their size and shape with novel experience and are thus considered to represent a structural trace of learning. Maja will share a demo of tissue preparation that is necessary for fluorescent confocal imaging of spines, and a basic operation of a confocal microscope.

## Acute Brain Slice Preparation: A Neurophysiology Workhorse

Acute brain slices were used as a preparation since the early twentieth century, first for biochemical measurements, and later on for electrophysiological recordings including patch-clamping of single cells. In this class, students will get a broad overview of physiology techniques used to interrogate neuronal function in acute brain slices. Attendees will also learn about challenges of preparing acute brain slices from adult and aging animals necessary for studies of neurodegeneration.

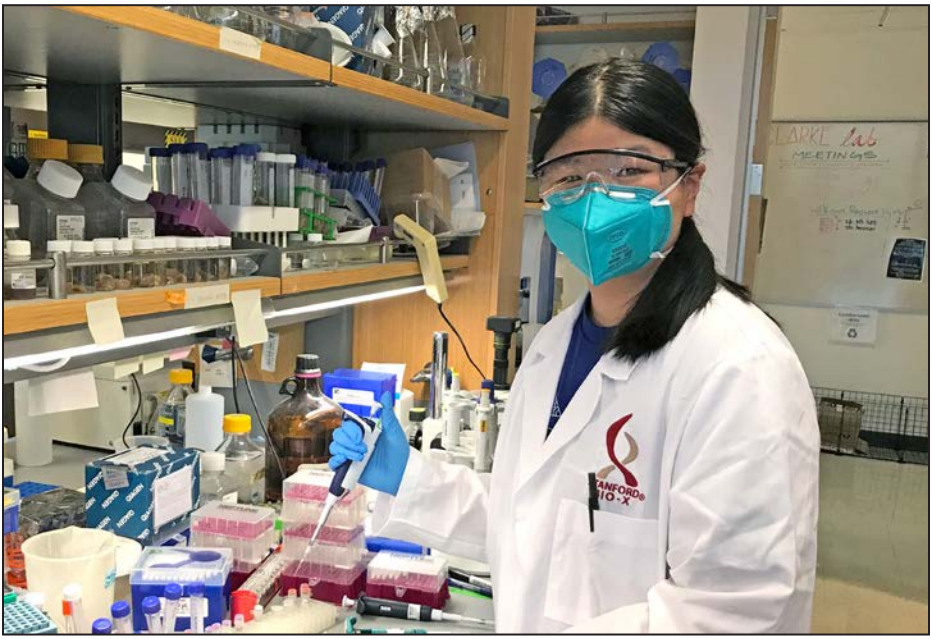
# Journal Clubs:

Dr. Maja Djurisic | Dr. Stephan Eismann | Dr. Makaía Papasergi-Scott | Dr. Aram Raissi | Annina Sartor | Dr. Alpay Seven | Dr. Justin Trotter

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

## Peer Shares:

Over the course of the summer, the Bio-X team will meet with smaller groups of our students at regular intervals. These meetings provide opportunities for students to present updates on their work with brief Powerpoint presentations, engage in peer discussion, receive feedback, and network with other members of their cohort.



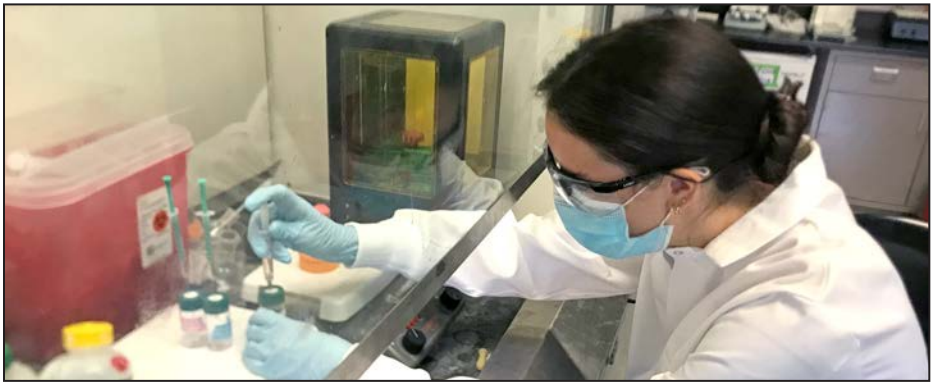

*Alice Wang will complete her Stanford Bio-X summer research training with Dr. Michael Clarke*

# 2021 Stanford Bio-X Undergraduate Summer Research Program Participants:

**Rashid Al-Abri, Computer Science**
***Mentor: Michael Snyder (Genetics)***
**A Polymorphic Catalog of Short Tandem Repeats Is Enriched for Clinically Relevant Genomic Regions**
Short tandem repeats (STRs) are repetitive DNA sequences that vary in length among individuals which makes them polymorphic. Through the use of STR catalogs, researchers have identified STRs implicated in Friedreich's ataxia and fragile X syndrome. Although most pathogenic STRs are polymorphic, the leading tool for generating such catalog produces sequences that are mostly not. By employing big data techniques, Rashid aims to show that a polymorphic catalog is more biologically and clinically relevant, enabling the scientific community to more easily discover novel STRs implicated in disease.

**Isaac Applebaum, Biology**
***Mentors: Robert M. Waymouth (Chemistry) and Grant Rotskoff (Chemistry)***
**Designing Improved Polymers for Application-Specific Gene Delivery with Graph Neural Networks and Non-Convex Optimization Algorithms**
The Waymouth lab has created polymers called Charge-Altering Releasable Transporters (CARTs) that carry genetic material, such as RNA or DNA, into cells. CARTs have been used to develop successful cancer immunotherapies and mRNA vaccines for COVID-19 in mice, applications that each require gene delivery to specific cell types and organs. Varying the chemical structure of CART polymers leads to remarkable variation in the cell types and organs that genetic material is delivered to, but these relationships between chemical structure and biological function are poorly understood. Working in the Waymouth and Rotskoff labs, Isaac will use cutting-edge machine learning techniques to elucidate these connections and design improved CART polymers that can meet the unique needs of cancer therapies, vaccines, and treatments for genetic disease.

**Kaleigh Beacham, Bioengineering**
***Mentor: Scott Delp (Bioengineering and Mechanical Engineering)***
**Using Machine Learning to Assess Knee Injury Risk from Video**
Anterior cruciate ligament (ACL) injuries are common, particularly during adolescence (Thompson et al. 2017). These traumatic injuries often require surgery and extensive rehabilitation and increase the likelihood of developing knee osteoarthritis. High knee valgus moment during a jump-landing is related to an increased risk of ACL injury (Thompson et al. 2017). Measuring the valgus moment requires force plates and motion capture, limiting its accessibility. Kaleigh's work will use data from Lucile Packard Children's hospital containing simultaneous 2D-video and motion capture of young athletes performing a jump-landing to train a machine learning model that predicts knee valgus moment using only 2D-video.



*Coco Sanabria will complete her Stanford Bio-X summer research training with Dr. Sarah Heilshorn*

*Benjamin Midler will complete his Stanford Bio-X summer research training with Dr. Shaul Druckmann*

**Rinni Bhansali, Electrical Engineering**
***Mentor: Manu Prakash (Bioengineering)***
**Platform and Pipeline Development for Microscopy-Based Diagnosis of Malaria and Other Infectious Diseases**
The Prakash lab is developing a low-cost autonomous microscopy platform (Octopi), which will play a pivotal role in humanity's fight against malaria. It will be a powerful diagnostic tool: one that is economical, but also as robust as manual microscopy. Rinni is helping develop Octopi for deployment, by assisting in (1) optimizing its functionality/lowering its cost through hardware development, (2) improving the robustness of its staining pipeline, and (3) enabling communication across various Octopi users to better harness the global insights such an accessible platform will generate.

**Amanda Cantwell, undeclared**
***Mentor: Allan Reiss (Psychiatry & Behavioral Sciences)***
**Analyzing the Roots of Social-Emotional Behaviors in Individuals with Klinefelter Syndrome (KS)**
This project will examine the influence of testosterone in male adolescent neurodevelopment, more specifically in boys aged 8-13 with Klinefelter Syndrome (KS). Boys affected by KS experience testosterone deficiency as well as neurocognitive issues including negative cognition and behavior. Amanda is analyzing the neural difference through code and comparing the pubertal difference to boys without testosterone deficiencies using data that her team is collecting on site. She is meeting by Zoom with the faculty mentor and project team biweekly to discuss findings and necessary steps to follow. The results will advance knowledge of neural changes during male puberty.

**Tony Chang, undeclared**
***Mentor: Paul Bollyky (Medicine - Infectious Diseases and Microbiology & Immunology)***
**Measuring Antibiotic Diffusion in Phage Liquid Crystals**
Pf bacteriophages organize *Pseudomonas aeruginosa* (Pa) biofilm polymers into crystalline, higher order structures. Pa biofilms that produce Pf phages are very resistant to antibiotic treatment, making these infections extremely difficult to treat. The Bollyky lab hypothesizes that Pf phages alter the electrical currents within biofilms, which would contribute to delayed wound healing in Pa infections. Tony is visualizing the crystalline structures formed by Pf using light microscopy and using an electrical resistance system to better elucidate how the Pf phage influences Pa biofilms and wound infections.

**Celia Charlton, Bioengineering**
***Mentor: Jennifer Cochran (Bioengineering)***
**Leveraging Enzyme Engineering to Make Plastic More Biodegradable**
The goal of the project is to aid the plastic pollution crisis by engineering a novel enzyme that can efficiently break down polylactic acid (PLA), a plastic commonly heralded as biodegradable replacement for mainstream plastics. Its biodegradation rate is negligible under typical conditions, leading to concern regarding its disposal and subsequent downstream environmental effects. Using an enzyme that is found in nature and has been shown to slowly degrade PLA, Celia is performing a high-throughput screen of thousands of mutants to improve its ability to degrade PLA. Mutations most beneficially altering the enzyme's PLA degrading activity will be combined to create super-mutants. Celia will then iterate on these super-mutant enzymes through multiple rounds of mutation, comparing their activity with the wild-type enzyme and identifying any important new mutations through sequencing. She plans to go through this screening process several times during the summer, with the hope of continuing this research after the Bio-X program.

**Crystal Chen, undeclared**
***Mentor: Richard Jaffe (Anesthesiology, Perioperative & Pain Medicine)***
**The Protective Effects of Mild Intraoperative Hypothermia during Revascularization Surgery for Moyamoya Disease**
Moyamoya disease (MMD) is a rare, cerebrovascular disorder in which arteries at the base of the brain become blocked, leading to stroke. MMD requires careful intraoperative management to preserve brain function during surgical revascularization to restore cerebral blood flow. With the guidance of Drs. Jaffe, Burbridge, and Heit, Crystal aims to determine the effectiveness of mild hypothermia for cerebral protection from acute intraoperative ischemia. Crystal is analyzing various characteristics of patients and their magnetic resonance imaging scans, comparing the outcomes of normothermic and hypothermic intraoperative management.

**Ryan Choeb, Biology**
***Mentor: Thomas Südhof (Molecular & Cellular Physiology)***
**Elucidating an Explicit Model for the Alternative Splicing of Neurexins**
The lab is working to understand how neurons communicate with each other across synapses. One well-characterized regulator of the synapse and neural network formation is a class of cell-adhesion molecules known as Neurexins (Nrxns). Mutations in genes encoding Nrxns and their binding partners have been implicated in neuropsychiatric disorders such as autism spectrum disorders (ASDs) and schizophrenia (SCZ). It is unclear whether these phenotypes are a result of mutations altering gene expression levels as opposed to changes in the types of Nrxn isoforms generated as regulated by a mechanism known as alternative splicing. Ryan is working to characterize an explicit model for the alternative splicing of Nrxns throughout the brain, which can begin to provide insight into its functional relevance at the level of circuit formation and behavior.

*Jacqueline Fong will complete her Stanford Bio-X summer research training with Dr. Anthony Wagner*

*Marvin Collins will complete his Stanford Bio-X summer research training with Dr. Stanley Qi*

**Sara Choy, Biology**

***Mentor: Matthew Wheeler (Medicine - Cardiovascular Medicine)***

**Transforming Healthcare Delivery in Peripartum Cardiomyopathy through a Deeper Understanding of Genetic Determinants**

Peripartum cardiomyopathy (PPCM) is a rare heart failure syndrome affecting women in the puerperal period and is the number one cause of death in pregnancy-related mortality in California. There is growing evidence that risk for PPCM has a genetic component. The goal of Sara's research is to find rare genetic variants that may be contributing to PPCM development. Sara is utilizing the Stanford-InterMountain HealthCare PPCM database and she will perform whole exome sequencing of samples from 100 women patients. Rare variants of a pre-specified list of 20 novel genes with a plausible role in PPCM development, as well as their genomic interactome, will be curated for potential pathogenicity and correlated with clinical features and outcomes. Sara aims to optimize health care delivery of PPCM through a genetic-based evaluation tailored to the specific needs of future patients to reduce the high risk of morbidity and mortality in women with PPCM.

**Marvin Collins, Bioengineering**

***Mentor: Stanley Qi (Bioengineering and Chemical & Systems Biology)***

**Designing an Accessible CRISPR Kit for High School Students**

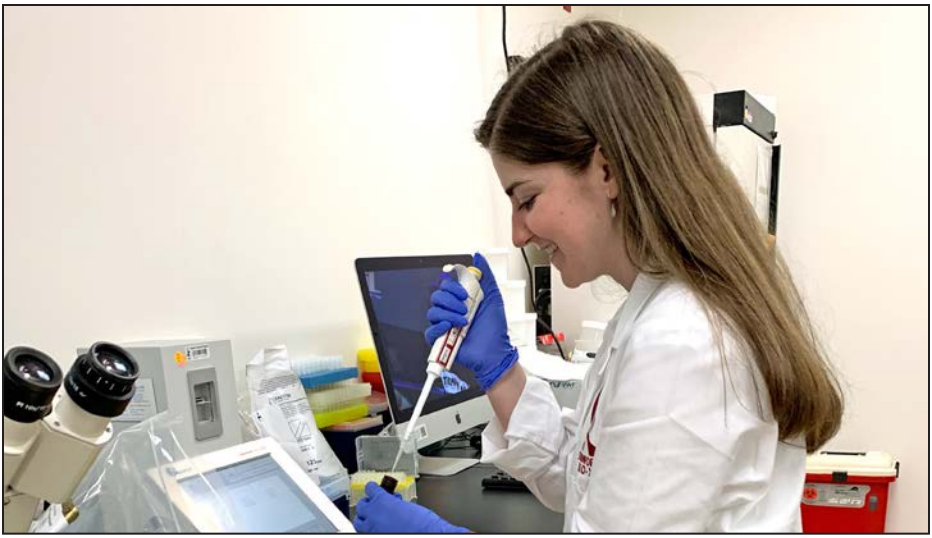
CRISPR gene editing technology is omnipresent in modern biological research, but the logistical and economic limitations of utilizing these techniques currently prevents high school students from gaining experience with them before attending a university. Marvin designing an educational kit that overcomes these limitations by utilizing novel materials and methods that have not yet been implemented in a CRISPR context. This kit will be able to offer new educational opportunities to students of varying socioeconomic backgrounds around the world.

**Daniel Contreras-Esquivel, undeclared**

***Mentor: Michelle Monje (Neurology & Neurological Sciences)***

**Myelin Integrity and Axon-Glial Connectivity in Autism Spectrum Disorders**

Myelin exhibit plasticity and may adapt with neuronal-activity-regulated oligodendrogenesis in the healthy brain, which can alter neural circuit function and behavioral output. Daniel is studying the role that adaptive myelination plays on the reward circuitry. By combining recombinase technology, microscopy, optogenetics, and behavioral assessments, Daniel will block the differentiation of oligodendrocytes within a mutant mouse model, and run social preference tests to investigate whether blocking the production of new oligodendrocytes can alter any reward circuitry behaviors.



*Jennifer Tashjian will complete her Stanford Bio-X summer research training with Dr. Emmanuel Mignot*

**Oscar Martin Cortes, Physics**

***Mentor: Edward Graves (Radiation Oncology - Radiation Physics)***

**The Immune Response of FLASH Radiotherapy in Immunocompetent Versus Immunocompromised Mice**

Oscar is comparing the immune responses of different mice between no radiation therapy, conventional radiotherapy, and FLASH radiotherapy. He is working to determine whether immune responses are required in FLASH radiotherapy by analyzing the tumor volume and the immune cell recruitment of the mice after radiation. Oscar is learning about immune system responses as well as the physics and biophysics of radiation therapy. He is also developing skills in animal handling, tumor inoculation, and statistical analysis methods.

**Emma Cruz, undeclared**

***Mentor: Craig Levin (Radiology - Molecular Imaging Program at Stanford)***

**Biodegradable SERS (Surface-Enhanced Raman Scattering) Supraparticles for *in vivo* Multicolor Imaging**

Tumors display significant heterogeneity in which multiple biomarkers need to be analyzed for patient-specific decisions. Emma aims to develop an *in vivo* multiplexed imaging method with surface-enhanced Raman scattering (SERS) nanoparticles for continuous and noninvasive monitoring of such heterogeneous tumors. In particular, Emma is working on the designed synthesis of biodegradable and translatable SERS nanoparticle imaging agents through (1) simulating suprastructures of renally clearable nanoparticles to determine which conditions provide high sensitivity for preclinical Raman imaging and (2) synthesizing such structures through chemistry efforts.

**Alvand Daliri, undeclared**

***Mentor: Kalanit Grill-Spector (Psychology)***

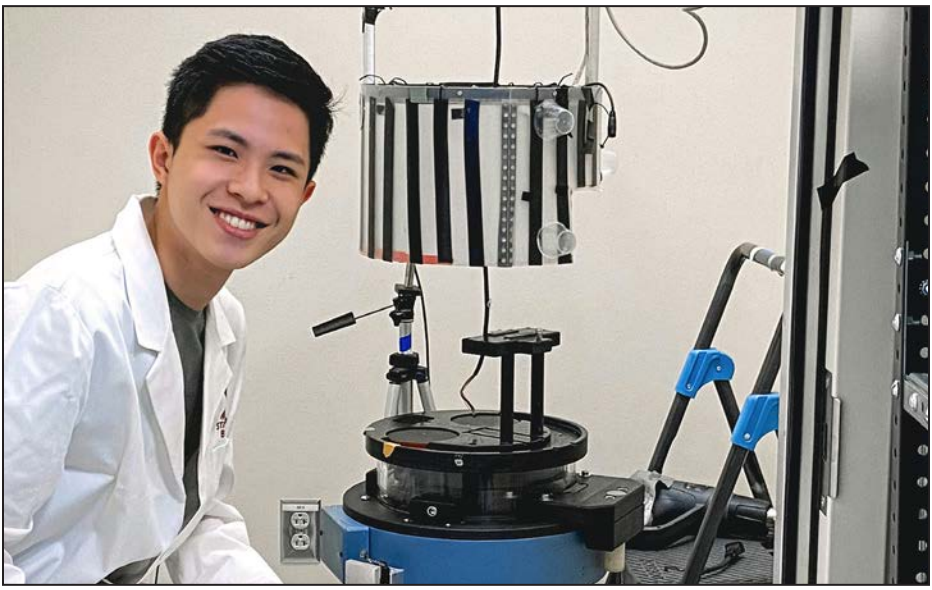
**A Data-Driven Approach to Defining the Boundaries of Cortical Layers from Ground-Truth Cell Density Measurements**

The Kalanit Grill-Spector lab studies developmental changes in the visual cortex, studying the neural anatomy and mechanisms which enable perception and affect cognition and behavior. There are a few functional areas that consistently arise within specific macroanatomical as well as microanatomical regions. Because each of these regions inhabits specific cytoarchitectonic areas in adults, each has a unique organization of cells that matches the organization of neuron cell bodies. However, the organization of glia, in particular astrocytes and oligodendrocytes, remains unknown. Alvand is studying glia organization across cortical layers and gain some insight into development in the visual cortex.

**Lorenzo Del Rosario, undeclared**
***Mentor: Andrew Fire (Pathology and Genetics)***
**A Bioinformatic Screen and Experimental Investigation of Large-Gene Regulators in *C. elegans***
The Fire lab studies how cells and organisms respond to genetic change. During nervous system evolution, many neuronal genes became extremely large and complex and are now frequently mutated or misregulated in neurological disorders and diseases. Lorenzo's research is jointly focus on (i) creating a computational pipeline to sift through an online database of *Ceanorhabditis elegans* mutants to identify regulators of large, complex genes, and (ii) experimentally validate putative large gene regulators by leveraging *C. elegans* genetics and transgenics. This research has the potential to uncover fundamental features of neurobiology as well as highlight novel targets for treatment of disease.

**Leila DeSchepper, undeclared**
***Mentor: Michael Howitt (Pathology and Microbiology & Immunology)***
**The Role of Intestinal Taste Cells in Modulating Antimicrobial Secretion**
Leila's project incorporates immunology with tissue stem biology to study the influence of type 2 immune cytokines on the differentiation of intestinal epithelial cells. Leila is utilizing flow cytometry and immunofluorescent microscopy in murine genetic models and primary intestinal organoids to elucidate how intestinal epithelial cells respond to the cytokine IL-13 whether by proliferation or influencing specific differentiation of stem cells. This study will provide insight into better understanding taste-sensory biology with innate immunology.

**Abhijit Devalapura, undeclared**
***Mentor: Mark Schnitzer (Biology and Applied Physics)***
**Quantifying Mouse Pain Behaviors**
Abhy is evaluating pain in mice before and after ligation of a facial nerve, as well as after a treatment to ease the pain. More specifically, he is using computer software to combine different types of data from mice to formulate a pain score that reflects the amount of pain the mice are experiencing in each of their states. He will use this data to evaluate the impact of treatment regiments in mice and to more easily compare mice and human datasets. From this project he will create a mouse pain scale that can be compared with the VAS scale commonly used to measure pain in humans.



*Kellen Vu will complete his Stanford Bio-X summer research training with Dr. Jennifer Raymond*

**Ellie Fajer, Biology**

***Mentor: Jason Andrews (Medicine - Infectious Diseases)***

**Identification and Characterization of Bacteriophages Infecting *Salmonella typhi* and Mechanisms of Resistance**

In previous sewer samples collected in Palo Alto, unspecific typhoid phages were uncovered. As this is unexpected in an area without endemic typhoid, further research is necessary to explain these findings. This project would include collecting more samples, then isolating and characterizing discovered phages based on the sensitivity of *Salmonella typhi* and other bacterial strains; if time allows, Ellie is also investigating if typhi strains can develop resistance to these phages, and if so, through what mechanism(s). This project will complement work in the lab on *Salmonella typhi* and typhoid phage ecology in Nepal and typhi resistance mechanisms.

**Bené Farrell, undeclared**

***Mentor: Henry C. Lee (Pediatrics - Neonatal & Developmental Medicine)***

**Evident Health Disparities amongst CA NICUs Donor Milk Distribution**

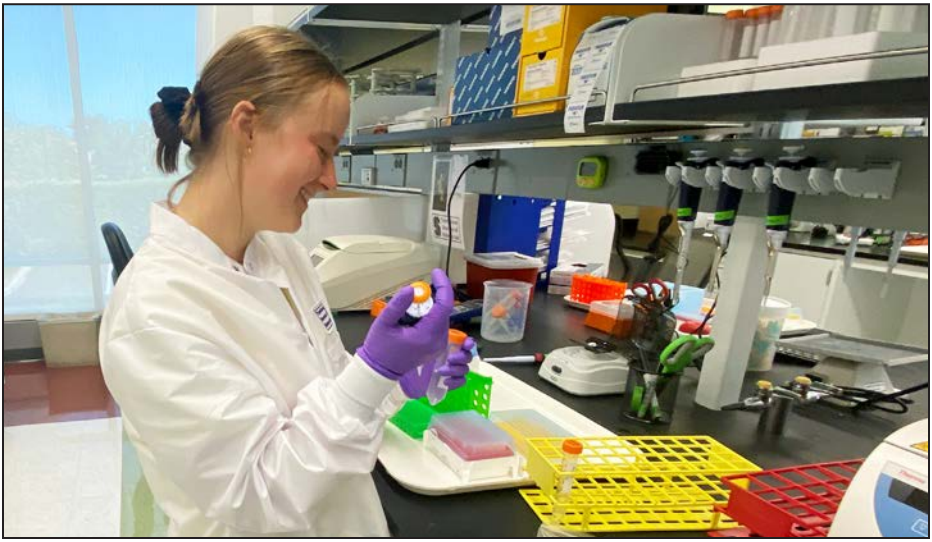
Perinatal health in particular is often a reflection of the power dynamic between physician and patients, dominated quite heavily by racial and socioeconomic disparities. Through this project Bene is comparing data of reported patient comfort levels to the susceptibility of the newborn to intake breast milk. The necessary data trends of comfort, class, and overall birth experience will be connected to racial genomic trends via the expressed FOLR1 receptor, an expressed gene during lactation in human milk cells. Bene is aided by data from 'Gene expression in breast milk cells is associated with maternal and infant characteristics'.

**Jacqueline Fong, Psychology**

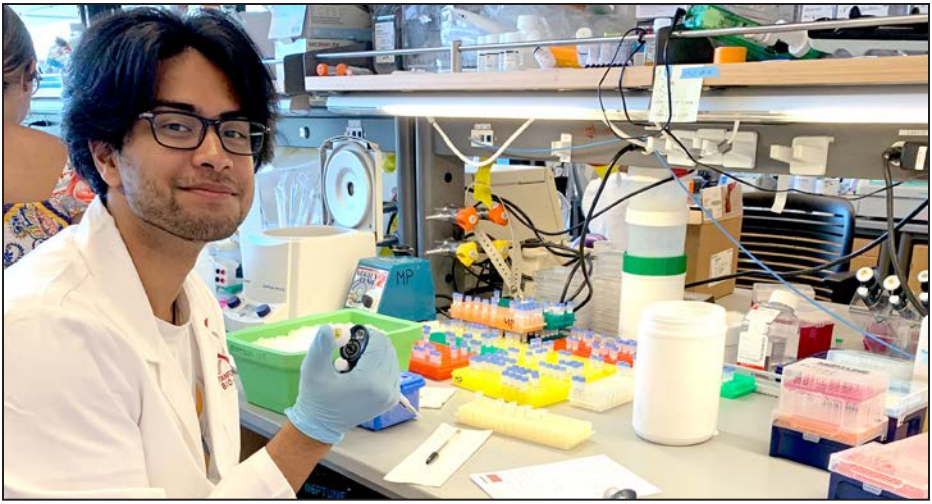
***Mentor: Anthony Wagner (Psychology)***

**Associations Between Cortical Thickness and Alzheimer's Disease Biomarkers in Cognitively Unimpaired Older Adults**

The integrity of the locus coeruleus (LC) is a possible preclinical biomarker for Alzheimer's disease. The proposed project will utilize previously collected high-resolution structural MRI data to analyze the LC, identify variability in older adults, LC integrity, and examine the relationship between LC integrity and cognitive decline. Jacqueline is learning how to manually delineate the LC from the structural MRI (N=180 older adults at 3T, N=160 older adults at 7T), and conduct volumetric analyses to investigate the relationship between LC integrity, molecular biomarkers of Alzheimer's disease (CSF amyloid beta and tau), and cognitive decline in healthy older adults.



*Alina Pollner will complete her Stanford Bio-X summer research training with Dr. Anna Gloyn*

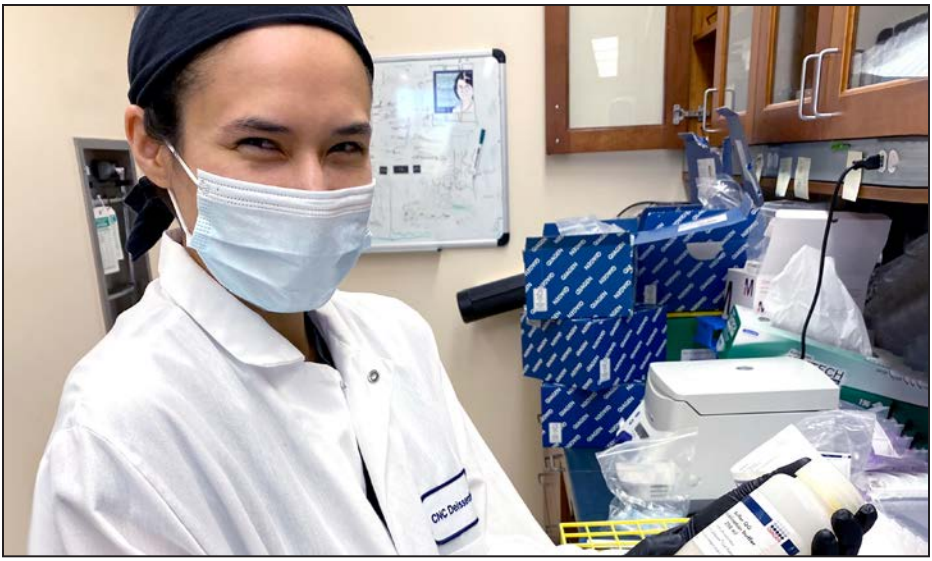


*Kiran Majeti will complete his Stanford Bio-X summer research training with Dr. Matthew Porteus*

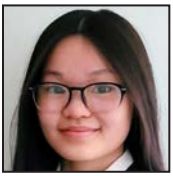
**Anudeep Golla, undeclared**
***Mentor: Anshul Kundaje (Genetics and Computer Science)***
**Developing the Architecture of BPNet: A Deep Neural Network Designed to Discover Genomic Regulatory Elements**
Transcription factors (TFs) are proteins that bind to genomes to regulate the expression of genes. Understanding the landscape of TF-binding interfaces is crucial to understanding disease. For example, the binding interface of TFs androgen (AR) and glucocorticoid (GR) can elucidate GR allowing functional substitution for AR in prostate cancers. A popular method of exploring binding interfaces is SelexGLM, which fits a feature-based linear model to binding interface sequences. Anudeep is developing a cost-efficient neural network that can replace the mathematical analysis of SelexGLM. This enhancement could allow for increased and more advanced investigation of binding interfaces central to diseases.

**Abigail Graber, Psychology**
***Mentor: Ian Gotlib (Psychology)***
**Associations Among Early Life Stress, Ventral Striatum Activation, and Adolescent Depressive Symptoms**
Individuals exposed to early life stress (ELS) are at high risk to be diagnosed with Major Depressive Disorder. In her project Abigail will examine the effects of ELS on functional connectivity in the ventral striatum in the brain and on subsequent depression using a richly characterized sample of 214 children ages 9-12 years. They hypothesized that ELS is related to blunted activation in the ventral striatum (measured in the scanner using a validated reward processing task), which in turn increases risk for developing depressive symptomatology in adolescence. Identifying reliable biomarkers of depression is critical in informing prevention and treatment efforts.

**Jason Guo, undeclared**
***Mentor: James K. Chen (Chemical & Systems Biology, Developmental Biology, and Chemistry)***
**Developing ALDH1B1 Gene Inhibitors to Suppress Cancer Growth with Chemical Synthesis**
In the Chen lab, Jason is developing ALDH1B1 inhibitors that can suppress colorectal and pancreatic cancer growth. Jason's primary goal is to develop ALDH1B1 inhibitors that are suitable for *in vivo* studies by optimizing their potency, selectivity, pharmacokinetics, metabolic stability, and safety. These studies will involve chemical synthesis, enzyme kinetics assays, and cell-based assays. Jason will also attempt to solve crystal structures of inhibitors bound to ALDH1B1, by using direct methods to determine atom positions within the unit cell.



*Victoria Helm will complete her Stanford Bio-X summer research training with Dr. Karl Deisseroth*



**Katie Han, undeclared**
***Mentor: Helen Bronte-Stewart (Neurology & Neurological Sciences)***
**Using RAFT to Predict Parkinsonian Traits**
Parkinson's Disease (PD) is a progressive neurodegenerative disease that affects millions of people worldwide. Currently, scientists are trying to understand how symptoms like tremor change over time in PD patients. Repetitive alternating finger tapping (RAFT) is a technique where patients rapidly tap two keys back and forth on a keyboard for a certain amount of time. Guided by the Bronte-Stewart lab, Katie is analyzing data from RAFT to demonstrate how the kinematics of RAFT may correlate with the change or development of certain Parkinsonian traits, such as tremor or gait impairment, over time. This may help scientists predict the development of certain symptoms as the disease advances and worsens, as well as create and tailor personalized treatment plans for each unique, individual case.

**Leah Harris, Psychology**
***Mentor: James Gross (Psychology)***
**Sleep Bruxism and Ideal Affect**
Dentists throughout the world have reported a spike in sleep bruxism complaints from patients throughout the COVID-19 pandemic. Sleep bruxism is the grinding and clenching of the teeth at night; impaired regulation of wake-time emotion could lie at the core of sleep bruxism. Drawing from both psychology and physiology, Leah seeks to determine if emotion regulation is significantly impaired in individuals with sleep bruxism, as well as testing its association with wake-time stress, and impaired sleep quality. She is accomplishing this by analyzing longitudinal data from physiological devices pertaining to jaw movement, sleep tendencies, heart rate variability, and daily activity.

**Victoria Helm, undeclared**
***Mentor: Karl Deisseroth (Bioengineering and Psychiatry & Behavioral Sciences)***
**Probing Synaptic Plasticity Mechanisms Underlying Learning**
The goal of Victoria's project is to investigate synaptic and neural circuit plasticity mechanisms underlying learning behavior. To achieve this, Victoria is helping to train live mice in a virtual reality learning task. She will help to optically record neural and synaptic changes as the mice perform their tasks. Victoria is studying behavioral tasks, learning about microscopy and relevant theory, while coding in MATLAB to examine the neural and behavioral changes that occurred during learning.

**Jordan Kaplan, Human Biology**

***Mentor: Marlene Rabinovitch (Pediatrics - Cardiology)***

**Developing a 3-Dimensional Reductionist Pulmonary Arteriole Model to Study Cell-Cell Interactions under Healthy and Pathologic Blood Flow**

A model for pulmonary arterioles is being developed using 3D-bioprinted fibrin tubes, endothelial cells (EC), and smooth muscle cells (SMC). The EC-SMC co-culture system will then be exposed to laminar shear stress (LSS, from normal blood flow) and high shear stress (HSS, from pathologic blood flow as seen in idiopathic pulmonary hypertension and Williams syndrome). Confocal microscopy and RNA sequencing will then be used to examine EC-SMC interactions and SMC proliferation under LSS and HSS. Eventually, a variation of this model using patients' stem-cell-derived ECs and SMCs may be used in high-throughput drug screening for potential therapeutics for pulmonary hypertension.

**Olivia Kline, Biology**

***Mentor: Kari Nadeau (Medicine and Pediatrics - Allergy & Clinical Immunology)***

**Immune Effects of Wildfire Exposure**

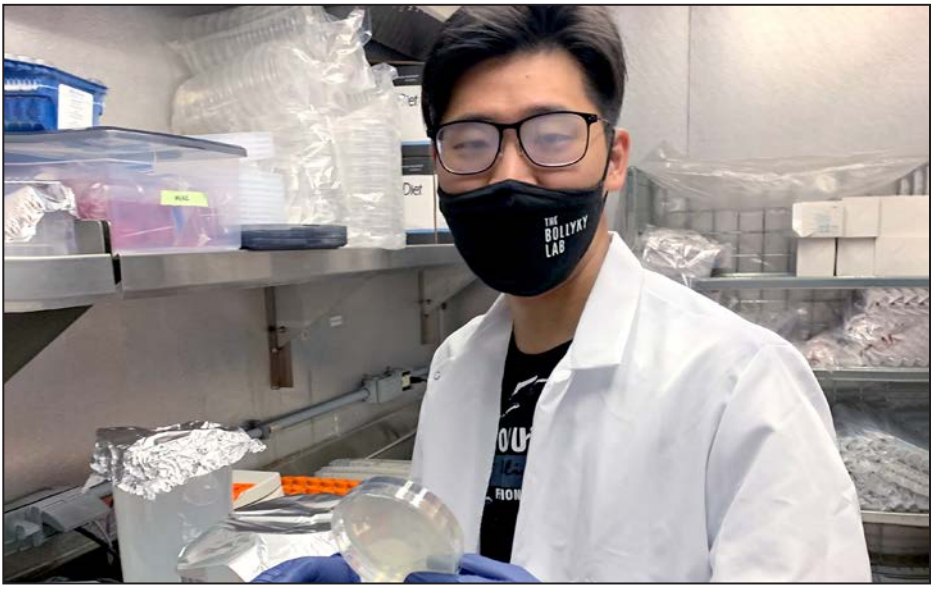
Air pollution exposure is detrimental to health. Given the increasing prevalence of fire smoke in the U.S., the need to understand the connection between smoke exposure with disease risk and/or severity and associated health risks is imperative. Therefore, research will explore the acute and chronic health effects of wildfire smoke in firefighters in the Bay Area. Olivia, is collecting blood samples from firefighters before and after smoke exposure. She will perform data analysis of levels of cytokines collected using a Luminex immunoassay platform.

**Alexander Kwon, undeclared**

***Mentor: Katherine Ferrara (Radiology - Molecular Imaging Program at Stanford)***

**Improved Synthesis of a Novel Cu-64 Multichelator for PET Imaging and Assessment *in vivo***

PET (positron emission tomography) utilizes radioactive tags to track the pharmacokinetics of therapeutic adeno-associated viruses (AAVs). The positron emitter Cu-64 is well-suited to monitor AAVs in blood and yields the best PET images when incorporated into multichelators. Alex's research is focusing on optimizing multichelator performance by proposing new methods of synthesis and evaluating functionality and the effects of PEG image quality in animal models.




*Tony Chang will complete his Stanford Bio-X summer research training with Dr. Paul Bollyky*

**Amaris Lewis, Biology**
***Mentor: Lauren O'Connell (Biology)***
**Hormonal Basis of Parental Care in Poison Dart Frogs**
Parental care is critical for infant wellbeing, yet little is known in vertebrates about how environmental cues affect parental decision-making. Using the poison frog *Ranitomeya imitator*, Amaris is quantifying neural circuitry controlling infant cannibalism versus infant care. In the laboratory, she will (1) quantify parental behavior within familiar/unfamiliar spaces using DeepLabCut—pose estimator software—(2) create the first ethogram for poison frogs, and (3) measure neural activity in both aggressive and affiliative parents using phosphoTRAP, exploiting phosphorylated ribosomes to approximate neural activity. Ultimately, this work will reveal whether specific neural markers correlate with parental decisions.

**Michelle Li, Human Biology**
***Mentor: William Hiesinger (Cardiothoracic Surgery)***
**Defining the Role of SDF-1α in Myocardial Recovery**
Ischemic heart disease is the leading cause of death worldwide. Michelle hypothesized that chemokines induce myocardial recovery post heart attack by differentially recruiting subpopulations of inflammatory cells. She is analyzing and processing next-generation single cell RNA sequencing data using Seurat on R, identifying differences in subpopulations of inflammatory cells and analyzing differential gene expression across these cell types. This remote project is allowing her to learn programming in R, identify cell types based on gene expression, and teaching her how to analyze and integrate single cell RNA sequencing data (a highly coveted skill), all while furthering the research goals of the lab.

**Brandon Lieu, undeclared**
***Mentor: Henry C. Lee (Pediatrics - Neonatal & Developmental Medicine)***
**Evaluating Trends Learned from a Collaborative Simulation and Debriefing Training Program in Neonatal Resuscitation: Simulating Success**
California Perinatal Quality Care Collaborative's Simulating Success program was designed to help hospitals implement on-site simulation-based neonatal resuscitation training programs. However, the program was not just a series of hands-on simulation trainings—a significant part of the simulation methodology involved having a debriefing session post-simulation. By evaluating and analyzing the debriefing videos data received from the hospitals over a 15-month period, Brandon hopes to elucidate common trends and lessons learned from this collaborative.

*Arman Sharma will complete his Stanford Bio-X summer research training with Dr. Euan Ashley*

*Melinda Zhu will complete her Stanford Bio-X summer research training with Dr. Keren Haroush and Dr. Shaul Druckmann*

**Aditi Limaye, Bioengineering and Mathematics**
***Mentor: Ansuman Satpathy (Pathology)***
**Characterization of PD-L1 Blockade Therapy Response**
Aditi's project combines data science and computational techniques with biology to annotate genes and analyze the RNA expressions comprehensively of over 100,000 patients to study how they differ significantly between tumor cells vs normal cells. This work will involve different databases and tackling biological and oncological topics to study 8 types of cancers as well as creating a CRISPR library.

**Bennett Liu, undeclared**
***Mentor: Dennis Wall (Pediatrics - Systems Medicine and Biomedical Data Science)***
**Utilization of Optum Databases to Understand Autism Spectrum Disorder (ASD) Treatment Patterns Based on Severity, Type, and Diagnosis**
The prevalence of Autism Spectrum Disorder has exponentially grown in the past 2 decades; however, it is not very well understood how clinicians adapt ASD treatment based on different ASD diagnoses (severity, type, and symptoms). Bennett is using SQL and leveraging insurance claims datasets from Optum Databases to analyze differences in ASD treatment based on ASD severity, type, and symptoms. Utilizing this rich database to understand better the adaptations that practitioners and clinicians make based on the ASD diagnosis can develop the understanding of trends in adaptation of treatment to the severity and type of ASD, and thus would be critical to better understanding ASD treatment.

**Ronan Locker, Engineering**
***Mentor: Wah Chiu (Photon Science Directorate, Bioengineering, and Microbiology & Immunology)***
**Atomic Resolution Analysis of the Varicella-Zoster Virus Utilizing Cryo-Electron Microscopy**
Under the direction of Dr. Wah Chiu and Dr. Stefan Oliver with Dr. Ann Arvin's lab, Ronan is analyzing the subcellular structures in the cryo-electron tomograms of varicella-zoster virus (VZV) infected MeWo cells. These tomograms were created to visualize the infection and assembly processes of VZV, and other structures within the cell. This project will involve data processing and analysis for feature extraction and annotation using neural network-based machine learning (ML). Through this project, Ronan will learn to analyze and visualize tomograms and ML methods. Furthermore, he is learning about the biological processes involved in VZV infection.

*Waymon Whiting will complete his Stanford Bio-X summer research training with Dr. Laura Dassama*

**Phoebe Loo, undeclared**

***Mentor: Erinn Rankin (Radiation Oncology - Radiation & Cancer Biology and Obstetrics & Gynecology - Gynecologic Oncology)***

**Investigating DNA Repair Mechanisms Behind FLASH Radiation Therapy in Ovarian Cancer**

Phoebe's project is focusing on comparing ultra-rapid (FLASH) irradiation to conventional radiation, and how FLASH selectively spares the tissue from radiation-induced toxicity. In particular, Phoebe will evaluate the effects on normal intestine and ovarian tumors in different genetic backgrounds including defects in various DNA damage repair pathways. Phoebe's research includes training in imaging analysis, cell culture, tissue harvesting, animal studies, and immunofluorescence.

**Ricardo Lopez, Biology**

***Mentor: Boris Heifets (Anesthesiology, Perioperative & Pain Medicine)***

**Cell-Type Specific Modulation of Hedonic Feeding**

Hedonic feeding is a hallmark of binge-eating behaviors. During this phenomenon, the rewarding qualities of food motivate intake that exceeds metabolic demand. The neural circuits governing the rewarding properties of food are incompletely understood. The nucleus accumbens, a basal forebrain region receiving extensive dopaminergic projections, operates as an integral node in reward and aversion processing. Ricardo is investigating the contributions of specific neuronal subtypes in the nucleus accumbens to hedonic feeding. Using a chemogenetic approach, we selectively activated and inhibited accumbal neurons in rodent models during the development of excessive high-fat intake. In doing so, we could assess how unique neuronal subtypes influence the rewarding characteristics of high-fat.

**Sierra Lore, Biology**

***Mentor: Chaitan Khosla (Chemical Engineering and Chemistry)***

**Quantification of Immunogenic Peptides from Dietary Gluten in the Urine of Patients with Celiac Disease**

Through peptidomics analysis, the Khosla lab has identified candidate biomarkers that distinguish patients with celiac disease (CeD) from healthy controls. The lab is interested in designing a quick, inexpensive immunoassay that predicts the health status of patients with CeD. Through peptide synthesis and site-selective chemical modification, Sierra is developing an immunoassay that measures the amount of peptide biomarkers that the lab has previously found. She will then assess the correlation between the concentrations of peptide biomarkers and celiac disease status using de-identified clinical data.

**Kiran Majeti, Biology**

***Mentor: Matthew Porteus (Pediatrics - Stem Cell Transplantation)***

**Inducible EPOR Signaling as a Means to Enrich for Edited Erythrocytes *in vivo***

Erythropoietin regulates the proliferation and differentiation of erythroid precursor cells, and is mediated by the erythropoietin receptor (EPOR). Clinical genetics studies have revealed the existence of a mutant EPOR where affected individuals present with elevated levels of red blood cells (RBCs) but minimal adverse effects. The Porteus lab has postulated that by introducing this EPOR mutation into edited hematopoietic stem cells (HSCs), they can bias a heterogeneous population of edited HSCs towards producing a greater proportion of edited RBCs; bypassing a major therapeutic bottleneck in gene therapy. By understanding the structure of EPOR, and using previous work in the Porteus lab Kiran has hypothesized that he can go one step further and create a chimeric, small-molecule sensitive EPOR that brings therapeutic control over the proportion of edited, differentiated RBCs.

**Vilina Mehta, Human Biology**

***Mentor: Michelle Monje (Neurology & Neurological Sciences)***

**Targeting GABAergic Neuron-Glioma Synapses in Diffuse Intrinsic Pontine Glioma (DIPG) through Anti-Epileptic Drug Repurposing**

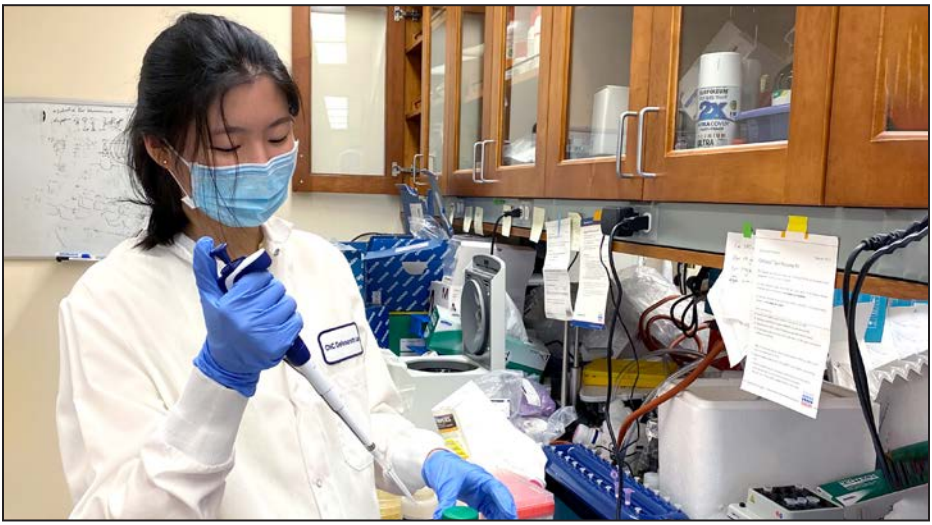
Recent work from the Monje lab uncovered the effects of neuronal activity on diffuse intrinsic pontine glioma (DIPG) progression, as electrochemical communication between neurons and glioma promotes DIPG growth. This raises the possibility that modulating neuronal activity with clinically available anti-epileptic drugs (AEDs) may reduce DIPG growth. However, because glioma cells are electrically responsive, medications designed to reduce electrical activity may have a direct effect on glioma cells. Vilina is performing computational RNAseq analysis of gene expression of AED targets in glioma cells and quantification of proliferation in AED-treated glioma xenografts to investigate the impact of AEDs on DIPG growth.

**Sherry Mestan, undeclared**

***Mentor: Anca Pasca (Pediatrics - Neonatal & Developmental Medicine)***

**Defects of Astrocytes in Human Brain Organoid Model of Hypoxic Brain Injury of Prematurity**

Sherry is studying the involvement of hypoxia on astrocyte maturation and brain injury. Sherry aims to identify cellular, metabolic, and molecular pathway defects in hypoxic astrocytes in order to pinpoint therapeutic targets for white matter injury of prematurity. Sherry's research will involve cell culture, immunocytochemistry, microscopy, confocal live imaging, quantitative polymerase chain reaction, metabolomics and transcriptomics.

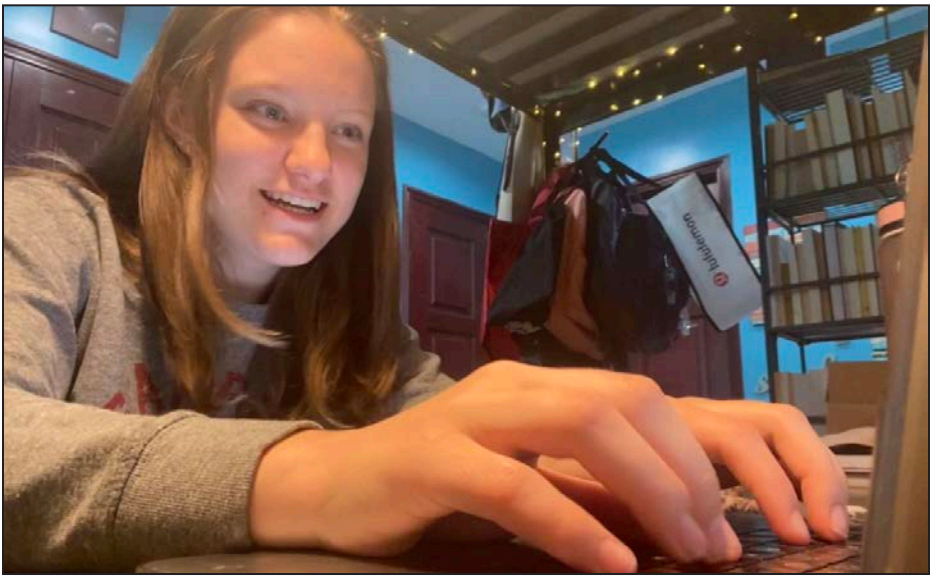


*Jenny Shi will complete her Stanford Bio-X summer research training with Dr. Karl Deisseroth*

**Benjamin Midler, Psychology**
***Mentor: Shaul Druckmann (Neurobiology and Psychiatry & Behavioral Sciences)***
**Computational Investigation of *Drosophila* Navigation**
Navigation is a key component of animal behavior. Vital for navigation computation is path integration (the ability to generate an online estimate of current position with respect to both a goal and the point of embarkment). How neural circuits implement path integration is unknown. Since *Drosophila* offer a suite of genetic tools, such as imaging and perturbation, along with detailed circuit mapping, they constitute an unrivaled opportunity to develop a mechanistic understanding of path integration. Benjamin is synthesizing calcium imaging recordings and circuit maps into a mathematical description of path integration.

**Khaing Mon, Symbolic Systems**
***Mentor: Keren Haroush (Neurobiology)***
**Analysis of Single-Cell Recordings Probing Fairness Sensitivity**
Khaing's research is probing fairness sensitivity and its neuronal basis at the single neuronal level in primates. Khaing is engaged in personally training macaque monkeys and understanding their behavior regarding reward maximization and fairness sensitivity. This study combines neuroeconomics, cognitive psychology, neurobiology and computational neuroscience to understand supply and demand and cognitive evolution and development.

**Daniel Newton, Physics**
***Mentor: Kerwyn Casey Huang (Bioengineering and Microbiology & Immunology)***
**Mathematical Modeling Microbial Community Response to Antibiotics**
Gut microbiota in healthy humans are extremely diverse, making them resilient against pathogenic invaders like *C. difficile*; however, antibiotics can decrease their diversity, rendering them invisible. Daniel is studying how microbial community richness changes in response to antibiotics by using computer simulations of the dynamical interactions of many different microbial species competing for resources. Daniel is also testing model predictions of microbial interactions by growing combinations of species against combinations of antibiotics. By comparing these simulations with experimental data of community diversity before and after antibiotics are applied, Daniel will quantify the accuracy of the lab's models and predict how antibiotic treatment alters community richness.



*Riley Stanford-Hill will complete her Stanford Bio-X summer research training with Dr. Craig Levin*

*Saw Kyaw will complete his Stanford Bio-X summer research training with Dr. William Weis*

**Ayush Pandit, Bioengineering**
***Mentor: Ron Dror (Computer Science)***
**Virtual Screening with Ligand Binding and Non-Binding Data**
Virtual screening is critical to the discovery of new drugs. Although virtual screening software is widely used in both academia and industry, its accuracy remains poor, posing major obstacles to effective drug design. Researchers in the Dror lab have developed a computational method, ComBind, that substantially improves virtual screening by combining physics-based structural modeling and machine learning. Ayush is extending ComBind to leverage information on ligands known not to bind the target—a plentiful source of experimental data that could make virtual screening much more powerful but is currently unused.

**Amari Paul, undeclared**
***Mentor: Maria Grazia Roncarolo (Pediatrics - Stem Cell Transplantation and Medicine - Blood & Marrow Transplantation)***
**Novel Approaches to Terminate Pediatric Acute Myeloid Leukemia Cells**
The Roncarolo Lab's research focuses on the antileukemia properties of CD4+ T cells engineered to express human IL-10 gene (LV-10) to bolster progress in killing pediatric acute myeloid leukemia. Amari is investigating the mechanisms underlying the anti-tumor capacity of the LV-10 cells through single-cell RNA sequencing and bioinformatic analyses. The in-depth preclinical studies will give us a better understanding of possible novel approaches to terminate pediatric AML cells in the near future.

**Richard Phan, Biology**
***Mentor: Vinit Mahajan (Ophthalmology)***
**Development of Calpain 5 (CAPN5) Associated Autosomal Dominant Neovascular Inflammatory Vitreoretinopathy (ADNIV) Mouse Model**
Uveitis, or intraocular inflammation, is a difficult-to-treat cause of vision loss that is responsible for up to 25% of cases of legal blindness. Its prevalence, severity, and limited treatment options underscore a critical need for new therapies. The Mahajan lab has found that patients with hyperactive mutation of CAPN5, a calcium-dependent protease, show the inherited form of uveitis. As of now, there lacks animal models that express hyperactive CAPN5 in the eye. Therefore, the lab is currently working on the development of an CAPN5 eye disease mice model. Establishment of CAPN5 eye disease mice model enables us to elucidate how CAPN5 plays a role in the intraocular inflammation pathway and develop CAPN5 inhibitive therapeutics to cure CAPN5-related uveitis.


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

**Nathan Phuong, undeclared**
***Mentor: Thomas Quertermous (Medicine - Cardiovascular Medicine)***
**Establishing the Lineage of Arterial Intimal Macrophages**
The Quertermous laboratory has mapped genes that contribute to coronary artery disease (CAD) genetic risk and employed single-cell RNA sequencing with mouse disease model tissues to study the functional role of these genes. Through this work, vascular cell phenotypic transitions and new cellular identities have been characterized, but the localization and movement of these cells during disease progression are unknown. Nathan is using RNA *in situ* hybridization of transition cell marker genes to characterize where these novel cells arise and what their relationship is to vascular structures.

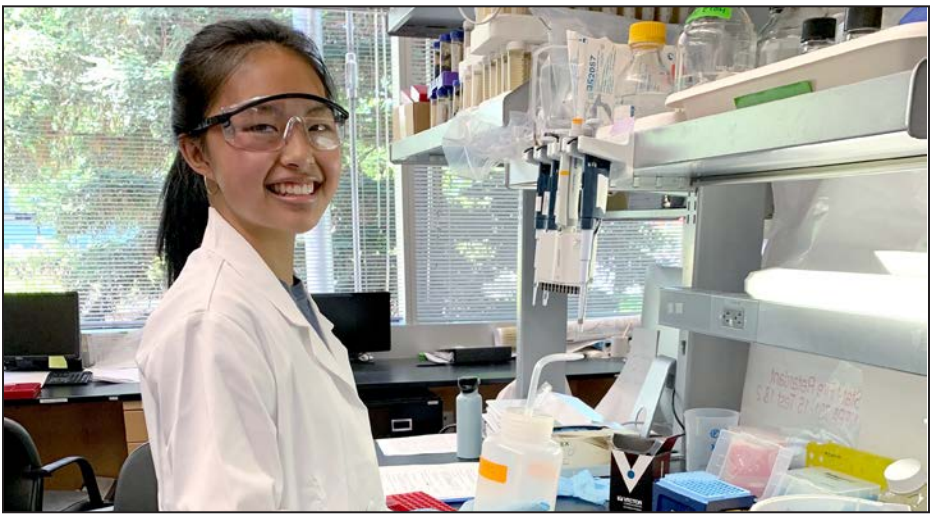
**Sammy Pickell, Human Biology**
***Mentor: Paul Bollyky (Medicine - Infectious Diseases and Microbiology & Immunology)***
**Pf Phage and *Pseudomonas aeruginosa* in Chronic Wound Infections**
The bacterium *Pseudomonas aeruginosa* (Pa) is a major cause of chronic wound infections, notable for alarming levels of antibiotic resistance. Pf bacteriophage, a virus produced by Pa, has been found to enhance the pathogenicity of Pa wound infections and decrease keratinocyte migration, and thus wound healing, through inhibition of CXCL1. Sammy is using wound models and cell culture systems available in the Bollyky lab together with phage engineering technology used in the Covert lab to interrogate the mechanisms behind these effects. These studies will contribute to novel treatments for chronic wound infections.

**Alina Pollner, undeclared**
***Mentor: Anna Gloyn (Pediatrics - Endocrinology & Diabetes)***
**Towards Discovering the Genetic Basis of Type 2 Diabetes through Antibody Immunoprecipitation**
Type 2 Diabetes is caused by a combination of genetic and environmental factors, affecting roughly 1 in 10 Americans. Thanks to a modern bioinformatic technique known as Genome Wide Association Studies (GWAS), hundreds of potential causal signals have been identified that might increase a person's risk in developing diabetes. Based on two of these signals, genes known as CALCOCO2 and PROX1, Alina is generating her own publicly available protein-protein interaction (PPI) dataset in both the human pancreatic beta-cell and liver cell model. This will be done by endogenous and overexpression immunoprecipitation and mass-spectrometry. After data analysis and assessment, Alina will integrate her findings with those from publicly available databases, hoping to better understand the mechanism behind a person's risk of developing diabetes.

**Sophia Pribus, undeclared**
***Mentor: Melanie Hayden Gephart (Neurosurgery)***
**Understanding the Impact of Primary Breast Cancer Hormone Receptor Status on Leptomeningeal Metastasis Development**
Development of metastases to the central nervous system (CNS) following the diagnosis of advanced breast cancer is an increasing clinical issue. Leptomeningeal metastasis (LM) is the most aggressive type of CNS metastasis and is rapidly fatal due to poor detection capability and limited therapeutic options. The relationship between the hormone receptor status of primary breast cancer and the propensity to LM is not understood. This project seeks to understand the metastatic pathway and possible predictors of LM development to improve patient prognosis and identify potential therapeutic targets. This is accomplished through retrospective patient chart review and single cell RNA sequencing.

**Gabriela Rincon, Physics**
***Mentor: Stephen Quake (Bioengineering and Applied Physics)***
**A Fluidic System for Long Time-Lapse Imaging of Adult Zebrafish**
The T cells and B cells of the adaptive immune system are thought to be essential in detecting and destroying early-stage malignancies throughout our lives. However, because these early-stage tumors remain undetectable in the vast majority of instances, it is difficult to study this process. Gabriela is combining an endogenous zebrafish melanoma model with transgenic fluorescent labeling of B and T cells to directly image the interactions between these cells and early malignancies. She is working with the Quake lab to engineer a system that allows for imaging all regions of the animal model over a long period of time.

**Madeleine Salem, undeclared**
***Mentor: Laramie Duncan (Psychiatry & Behavioral Sciences)***
**A Statistical Analysis of the Genetic Architecture Underlying Psychiatric Disorders**
Many genetic risk factors for mental health conditions like schizophrenia and depression have been identified in the last five years. The current challenge is to uncover their biological meaning. Madeleine's project is to computationally develop a pipeline for improved analysis of genetic sequences associated with certain mental illnesses. This project involves foundational statistical analysis methods including genome wide association studies (GWAS), polygenic scoring, and MAGMA pathway analyses. Through investigating the genetic architecture of schizophrenia and depression, Madeleine's work will aid in making novel discoveries about biological mechanisms underlying psychiatric disorders and how these mechanisms influence the onset of psychiatric disorders.



*Phoebe Loo will complete her Stanford Bio-X summer research training in Dr. Erinn Rankin's lab*

**Coco Sanabria, undeclared**

***Mentor: Sarah Heilshorn (Materials Science & Engineering)***

**Design of Universal Orthogonal Crosslinkers for 3D Bioprinting of Multi-Material Constructs**

3D bioprinting, a powerful technique for patterning living cells and biomaterials, has demonstrated the potential to replicate the complex spatial patterning of biomaterials within native tissues. The Heilshorn lab has recently developed a diffusion-based, universal crosslinking strategy that allows for the crosslinking of multiple printed biomaterials using a single mechanism. Coco is using CAD software to design multi-material structures that mimic spatial orientations of human tissues, and then model the crosslinking diffusion and reaction steps within the CAD structures on COMSOL, a multi-physics simulation software. This project will provide physiologically-relevant designs for bioprinting tissue-like constructs and give insight to the material crosslinking process.

**Tanner Scott, Human Biology**

***Mentor: Antonio Hardan (Psychiatry & Behavioral Sciences)***

**Understanding the Neurobiology of Autism: From Observational Studies to Clinical Trials**

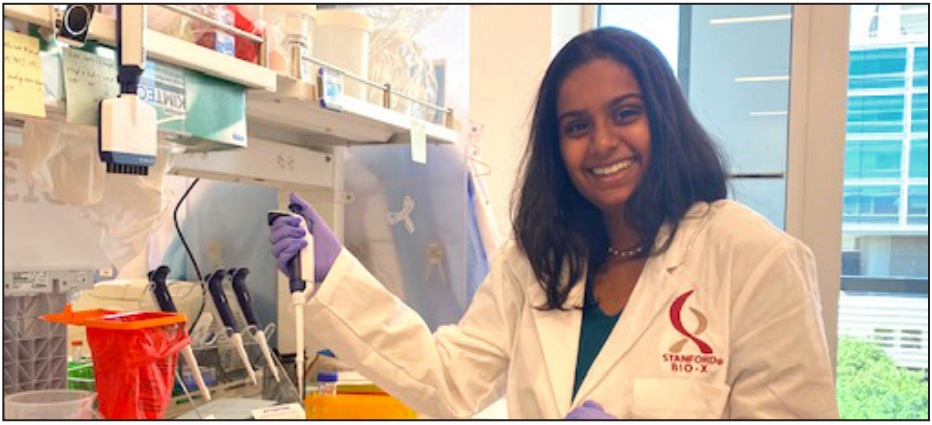
The Hardan lab studies human participants using neuroimaging techniques like MRI and EEG to understand the neurobiology of autism spectrum disorder (ASD) and assess new treatments for ASD, including transcranial magnetic stimulation, an exciting potential treatment approach. Tanner is analyzing psychometric and neuroimaging data to understand the neurobiology of ASD and the efficacy of treatments while learning research techniques to develop and answer a research question and present his findings. He is shadowing screening and behavioral testing with participants over Zoom and is learning to analyze data remotely using online software like REDCap.

**Arman Sharma, undeclared**

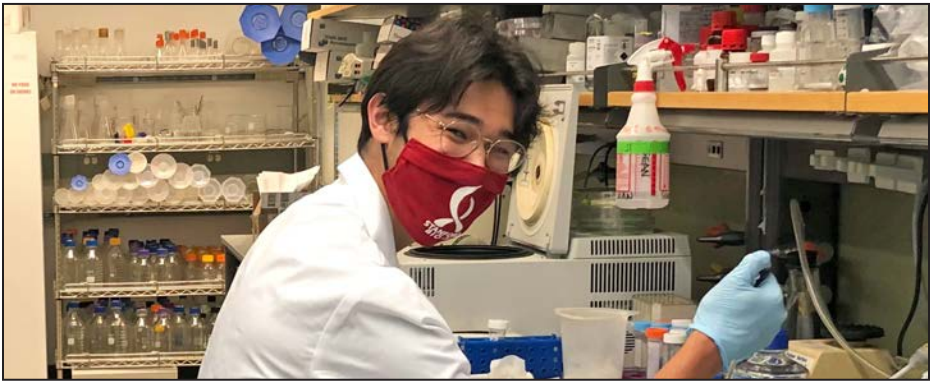
***Mentor: Euan Ashley (Medicine - Cardiovascular Medicine, Genetics, and Biomedical Data Science)***

**Constructing a Library of Pathogenic Mutations in TNNT2 to Enable Personalized Treatment for Hypertrophic Cardiomyopathy**

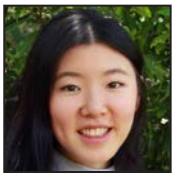
Heart disease is the leading cause of death in the United States. Genetic factors, including inherited mutations at certain loci including TNNT2 (Cardiac muscle troponin T) play a significant role in disease susceptibility. The advent of rapid and accessible genetic testing provides an opportunity to map the genetic variants that contribute to disease, enabling early detection and personalized gene therapies. Arman's study aims to identify genetic variants at every position in TNNT2 that yield a pathogenic phenotype. Arman is utilizing cutting-edge CRISPR-based gene editing tools and computational sequence analysis tools to establish connections between mutations and pathogenicity, thus potentially developing gene-based therapies for cardiomyopathy.




*Aditi Limaye will complete her Stanford Bio-X summer research training with Dr. Ansuman Satpathy*



*George Nakahara will complete his Stanford Bio-X summer research training with Dr. Thomas Südhof*



**Jenny Shi, undeclared**

***Mentor: Karl Deisseroth (Bioengineering and Psychiatry & Behavioral Sciences)***

**Single-Cell 3D Chromatin and Spatial Transcriptomic Characterization of the Cerebellum During Normal Development and Autism**

Studying the single-cell 3D genome and spatial transcriptome of the brain can elucidate relationships between DNA structure, gene expression, and brain circuitry in mental disorders and enable effective treatments. However, this is difficult with existing technology. To better understand the molecular differences between brains with and without autism, Jenny is integrating single-cell data from Dip-C (visualizes how chromosomes are organized in a cell) and STARmap (maps and sequences single RNA molecules in the brain). She is developing algorithms to characterize how the 3D genome and transcriptome change and interact during the development of mouse and human cerebellums.

**Jennifer Soh, undeclared**

***Mentor: Casey Gifford (Pediatrics - Cardiology)***

**Identifying Vital Enhancers for Faithful Cardiovascular Development**

The goal of the project is to identify the important enhancers that are necessary for accurate cardiovascular development. To this end, Jennifer is focusing on enhancer RNA (eRNA), a reliable indicator of functional enhancers, to give her insight into the activity of relevant transcription factors. She is producing both wildtype and mutant variants of three cardiovascular cell types by stem cell differentiation and compare their eRNA landscapes through sequencing. If successful, this work will ultimately help us understand how mutations in transcription factors lead to congenital heart disease.

**Michael Spear, Bioengineering**

***Mentor: Aaron Straight (Biochemistry)***

**Determining the Role of Nucleic Acid Binding by M18BP1 in Centromere Assembly**

The centromere is the essential chromosomal site for mitotic spindle interaction during chromosome segregation. Centromeres are defined by the presence of the centromere specific histone H3 variant, CENtromere Protein A (CENP-A). CENP-A assembly depends on a three-protein complex termed the Mis18 complex (Mis18α, Mis18β, and M18BP1). Exactly how this process is localized at the centromere or how it functions in CENP-A assembly is unknown. The M18BP1 subunit of the complex has been shown to have nucleic acid binding domains which may be important for its role in centromere assembly. In order to understand whether M18BP1's nucleic acid binding is important for CENP-A assembly, Michael is generating and analyzing M18BP1 mutants with deleted DNA binding domains in an effort to understand how M18BP1 recognizes the centromere. This research will help to understand how cells maintain the centromere for accurate chromosome segregation to avoid cancer associated aneuploidy and cell death.

*Jordan Kaplan will complete his Stanford Bio-X summer research training with Dr. Marlene Rabinovitch*

**Riley Stanford-Hill, Engineering**
***Mentor: Craig Levin (Radiology - Molecular Imaging Program at Stanford)***
**Modeling a Large Volume Cadmium Zinc Telluride PET System for Multi-Scatter Information**
Riley's project is combining computer science, physics, biology, and engineering to develop a more sensitive PET (positron emission tomography) system with the hopes of applying it for detecting neurodegenerative diseases and more. Riley will perform experimental studies which include computational skills and high energy physics and will hopefully be translated into small animal studies.

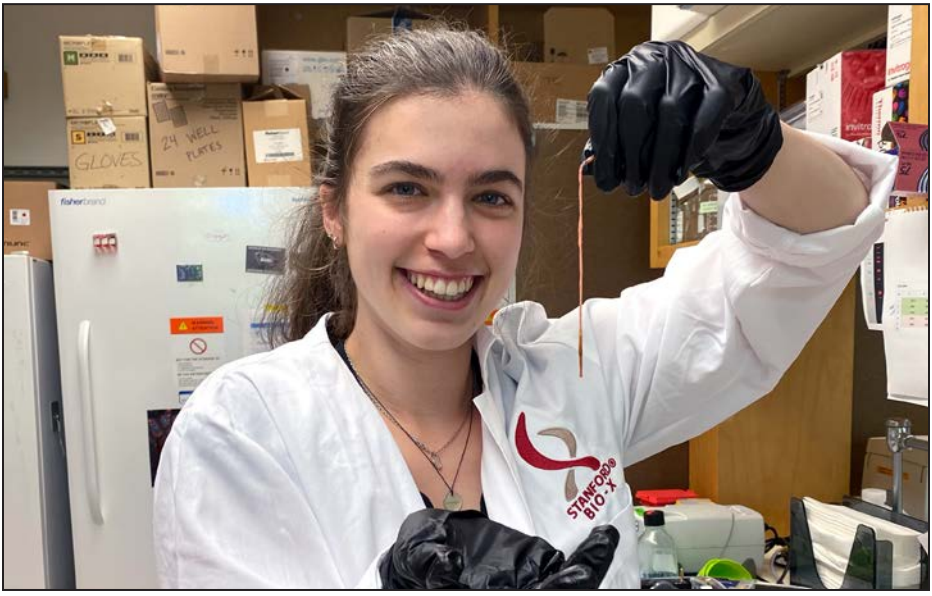
**Jennifer Tashjian, undeclared**
***Mentor: Emmanuel Mignot (Psychiatry & Behavioral Sciences)***
**Examining the Relationship between Circadian Cycles and Breast Cancer Progression and Severity**
Normal sleep circadian rhythms are indispensable to human health, and sleep deprivation has established consequences on metabolic disorders, cardiovascular disease, immune dysregulation, and cancers. Jennifer is using previously collected samples to test the dim-light onset melatonin (DLMO) in women with breast cancer and a control group, matching it with the SomaLogic proteomic profile predicting phase. The transformative, aptamer-based technology allows the accurate measurements of 5,000 proteins in 100Œ°l of plasma (or urine). Jennifer is working with Dr. Mignot's team to analyze samples in the lab and uncover important information regarding circadian disruption and breast cancer prevalence and severity.

**Caroline Van, undeclared**
***Mentor: Benjamin Good (Applied Physics)***
**Strain-Level Dynamics during Fecal Microbiota Transplantation**
Fecal microbiota transplantation (FMT) shows great promise for treating a variety of gastrointestinal disorders. However, little is known about how these transplanted strains evolve after engrafting in their new host. Caroline is analyzing existing sequence data from human gut microbiomes sampled before and after FMT to track genetic variants that occur within individual species. She will then use population genetic modeling to quantify the rates of mutation accumulation and horizontal gene transfer in native and transplanted strains. These evolutionary mechanisms have important implications for engineering gut microbiota to improve and optimize human health.

**Amberly Vu, Biology**
***Mentor: Hunter Fraser (Biology)***
**Next-Generation Genome Writing with Diverse Bacterial Retrons**
CRISPR has revolutionized genome editing, but it remains challenging to write long sequences into the genome efficiently. To address this, the Fraser Lab has developed CRISPEY, a CRISPR-based technology that enables genome writing that is both high-throughput and precise. CRISPEY uses retrons, which are bacterial genetic elements that can reverse transcribe RNA into multicopy single-stranded DNA (msDNA). Amberly is improving CRISPEY by testing the ability of a collection of natural retrons from multiple species to produce msDNA as donor DNA, facilitating enhanced homology-directed repair (HDR) and allowing long DNA sequences to be written into the genome.

**Kellen Vu, undeclared**
***Mentor: Jennifer Raymond (Neurobiology)***
**Adaptive Tuning of the Oculomotor Integrator Dynamics in Mice**
The central function of neural circuits is to perform computations, using the dynamics of large, recurrently connected populations of neurons. Kellen's project aims to use the oculomotor system as a model for how these computations are adaptively modified by experience to improve the performance of the systems involved. To do so, he is implementing a behavioral training protocol in mice to artificially "tune" the oculomotor integrator. His specific aims are: (1) to optimize and rigorously document the training procedures for inducing adaptive tuning of the oculomotor integrator, and (2) to test how the integrator depends on the cerebellum by optogenetically inhibiting Purkinje cells in mice.

**Alice Wang, Biology**
***Mentor: Michael Clarke (Medicine - Oncology)***
**Genome-Wide Profiling of Histone Modifications in Breast Cancer Stem Cells**
Alice is investigating the epigenetic regulation of cancer stem cells to better develop treatments for different cancers through the fields of organic chemistry and medicine. This project will combine sequencing techniques with chromatin immunoprecipitation quantitative polymerase chain reaction and 3D organoid culture assays as well as computational analysis to better visualize and understand the epigenetic status of cancer stem cells.




*Leila DeSchepper will complete her Stanford Bio-X summer research training with Dr. Michael Howitt*

*Alexander Kwon will complete his Stanford Bio-X summer research training with Dr. Katherine Ferrara*

**Ameera Waterford, undeclared**
***Mentor: Claudia Petritsch (Neurosurgery)***
**Understanding the Effects of Targeted Drugs on Pediatric Brain Tumors**
The Petritsch Lab uses patient-derived brain tumor cells to produce patient avatars that can be used to predict a patient's response to different drug therapies. Ameera is using 2D- and 3D-spheroid cultures to study how targeted anti-tumor drugs (predicted by computer-based analyses of RNA expression profiles) affect the tumor cells of a specific patient. These methods will be particularly useful because they allow the lab to study characteristics like cell migration and changes to the tumor microenvironment in a shorter timeframe than experiments in mice. This work will also produce dose-response curves that will contribute to the early-stage development of personalized treatment for pediatric cancer patients.

**Waymon Whiting IV, undeclared**
***Mentor: Laura M. K. Dassama (Chemistry)***
**Mechanistic Investigations of Divergent Multidrug Transporters**
Multidrug resistant (MDR) bacteria pose a challenging human health problem. One of the mechanisms driving MDR is the secretion of antibacterial drugs by multidrug efflux pumps. Drug efflux pumps are poorly characterized and therefore difficult to develop inhibitors for. Waymon's project focuses on a divergent group of efflux pumps belonging to the multidrug and toxin efflux family that are thought to transport drugs as well as secondary metabolites. The mechanisms of drug and metabolite binding and efflux are not known. Waymon is using structural, bioinformatic and biochemical approaches to elucidate the mechanism of these proteins, with the goal of helping to disable efflux pumps in the context of MDR.

**Melinda Zhu, Computer Science**
***Mentor: Keren Haroush (Neurobiology) and Shaul Druckmann (Neurobiology and Psychiatry & Behavioral Sciences)***
**Applying Deep Learning to Social Gaze Patterns in Competitive and Cooperative Decision-Making**
Among rhesus macaques, the gold standard of neurophysiology research, eye contact is interpreted as an aggressive cue and is unlikely to be utilized in prosocial interactions. However, other primates such as humans and marmosets can use direct gaze prosocially. In this project, Melinda is designing various tasks involving collaborative and competitive behaviors among marmosets, which will be recorded and used for the refinement of machine vision algorithms that can track marmosets' gazes. By perturbing activity in areas of the social brain and other network nodes, these algorithms will lead to understanding how neuronal changes in primates affect social gaze patterns.

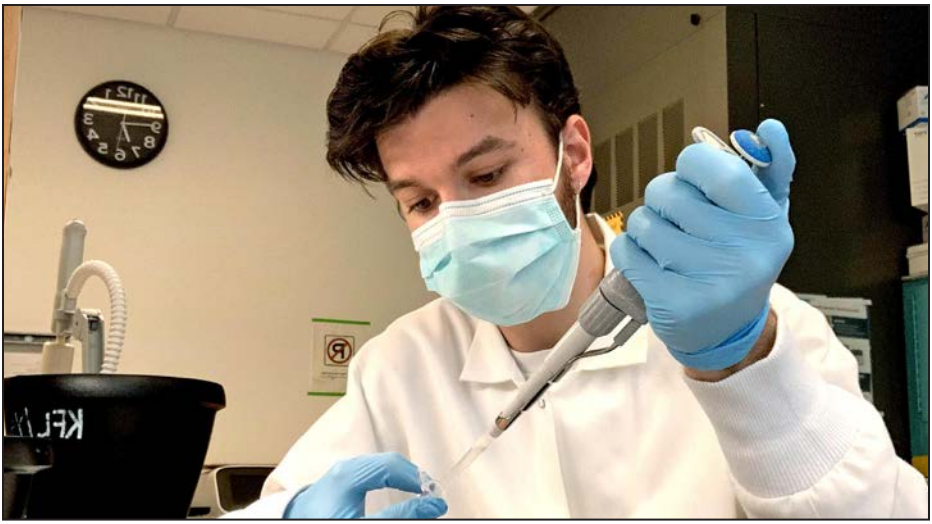
# 2021 Stanford Bio-X Undergraduate Summer Research Program Cohort Leads:

**Peyton Freeman, Bioengineering**
***Mentor: Fan Yang (Orthopaedic Surgery and Bioengineering)***
**Engineering Dual Functional Scaffolds to Enhance Bone Formation via Immunomodulation and Drug Delivery**
This project aims to validate a new therapy for regenerating cranial bone through co-delivery of growth factor and cell-membrane coated hydrogels. Using a mouse model, the Yang lab has shown BMP2 and MSC cell membrane coated microribbon hydrogels synergize to enhance bone formation. Peyton is performing further *in vitro* assays to elucidate the underlying mechanisms, and learn various softwares (ImageJ, GraphPad, and Microview) to analyze histology and microCT imaging results from mouse models. She will also participate in weekly lab meetings, subgroup meetings and journal clubs to learn experimental design and research methods.

**Saw Kyaw, Human Biology**
***Mentor: William Weis (Structural Biology, Photon Science Directorate, and Molecular & Cellular Physiology)***
**Understanding the Wnt Protein Pathway**
Human cells communicate to each other through systems that include key proteins, one family of which is called the "Wnt" protein. This protein is important for cell growth, and when the communication is disrupted, this leads to developmental disorders and cancer. However, it is unclear how the Wnt protein works within and between cells to initiate growth. Saw's project aims to create a mathematical model to understand the systems at work and validate the model with experimentation. By predicting how the Wnt protein from one cell interacts with the proteins on another cell, the model has implications on understanding how cancer cells act and will aid in the development of regenerative medicine.

**George Kenji Ikaika Nakahara, Human Biology**
***Mentor: Thomas Südhof (Molecular & Cellular Physiology)***
**Investigating the Role of Astrocytic Neurexin-1 in the Formation and Maintenance of the Blood-Brain Barrier**
The blood-brain barrier (BBB) is an important border that keeps pathogens and other harmful materials from penetrating into the central nervous system. Recent work from the Südhof lab has revealed that a protein called neurexin-1 is trafficked to the BBB by glial cells known as astrocytes. Neurexin-1 has previously been known to interact with a variety of postsynaptic ligands and organize diverse synaptic properties. However, its interactions with the BBB remain uncharacterized. George's research will explore how knocking out astrocytic neurexin-1 affects BBB structure and morphology. This investigation will explore a potentially novel role of neurexin-1 and provide greater insight into the formation and maintenance of the BBB.


*Peyton Freeman will complete her Stanford Bio-X summer research training with Dr. Fan Yang*



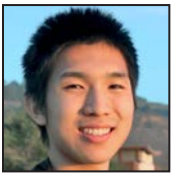
*Ryan Choeb will complete his Stanford Bio-X summer research training with Dr. Thomas Südhof*

**Lorena Orozco, Human Biology**
***Mentor: Brian Kobilka (Molecular & Cellular Physiology)***
**The Role of G Protein Conformational Changes in Receptor Mediated Signaling**

Opioids such as morphine activate a mu opioid receptor to mediate its pain-relieving effect. These effects results from the opioid activating the receptor and the receptor then in turns activates a G protein. To understand how this effect is mediated at the G protein, the Kobilka lab is using a biophysical approach called single-molecule FRET to measure the changes in the conformation of the G protein before, during and after engagement with the receptor. These changes are measured by assessing the amount of energy that is transferred between two probes labelled on the G protein. High transfer of energy implies the probes are closer and low transfers of energy imply the probes are further away. Using this as a measure, we can follow how the G protein is changing during interactions with the receptor.

**Sergey Pavlov, Biology**
***Mentor: Sergiu Pasca (Psychiatry & Behavioral Sciences)***
**Investigating the Impact of FDA-Approved Drugs on Neurodevelopment in Organoids**

Abnormal synaptic elimination has been associated with Autism Spectrum Disorder (ASD). Astrocytes are known to modulate synapse formation and elimination, however their role in disease pathogenesis remains unclear. The Pasca Lab has genetically engineered human pluripotent stem cells to carry deletions in five high-risk ASD genes and used them to derive cerebral cortex organoids. Sergey is asking if astrocytes isolated from these mutant cortical organoids show defects in their ability to phagocytose synaptosomes by analyzing data from an engulfment assay and contributing to designing experiments to test roles of astrocytes in ASD.



**Vincent Xia, Chemical Engineering**
***Mentor: Gerald Fuller (Chemical Engineering) and David Myung (Ophthalmology)***
**Quantifying the Effects of Polar Lipid Proportions on Model Tear Films**

We currently have a limited ability to treat widespread ocular diseases such as dry eye disease. Although defects in the lipid layers of the eye are common culprits for dry eye disease, their specific effects are still unclear. In order to gain insight into the fundamental causes of dry eye disease, Vincent aims to quantify the effect of lipid deficiencies on the thin liquid films (tear films) that cover the surface of the eye.

# Stanford Bio-X Undergraduate Summer Research Program

*2019 Stanford Bio-X Undergraduate Summer Research Program Participants*

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**contact-biox@stanford.edu**