



**STANFORD
BIO-X**



**UNDERGRADUATE SUMMER
RESEARCH PROGRAM 2020**

STANFORD BIO-X UNDERGRADUATE SUMMER RESEARCH PROGRAM



2019 Undergraduate Summer Research Program (USRP) Participants

The outbreak of COVID-19 has placed tremendous and unanticipated pressures on individuals and organizations around the world. The Stanford community, with its unique culture of collaboration and innovation, has risen to the challenge.

Faculty, students, and staff from countless departments have come together and pooled resources to provide new insights by studying the virus, analyzing and predicting its spread, and diligently researching tests and treatments. Stanford has also hosted numerous virtual conferences attended by thousands worldwide.

Facing the pandemic head-on, for the 16th year of our Stanford Bio-X Undergraduate Summer Research Program, we have successfully adapted the program to allow for a vigorous, valuable, and fulfilling virtual undergraduate experience, maintaining our commitment to sharpening students' research skills and techniques despite the distance.

The Stanford Bio-X USRP has provided a ten-week summer research opportunity to a total of 708 students to date. We have partnered with 303 Stanford faculty mentors to provide this one-of-a-kind educational opportunity to these passionate young researchers. Our 2020 cohort of 66 students and their respective laboratories have adjusted the students' projects so that their research can be conducted long-distance. To keep our community intact and vibrant during these unprecedented times, this year Bio-X went above and beyond to incorporate interactive new experiences for the cohort and expanded the program to include more higher-level scientists than ever. **We involved 22 postdocs, graduate students, researchers, and senior-level undergraduates to facilitate fulfilling new connections and networks, to better simulate an on-campus experience.**

Bio-X has sustained the hallmarks of our summer program in a virtual format so that students can participate live from home. As always, our weekly faculty talks exposed students to the broad range of scientific fields and research that takes place at Stanford and directly introduced them to dozens of Stanford faculty members eager and willing to share their personal journeys to research as well as their laboratory work. This year's program culminates with students designing presentations detailing the progress of their summer work, giving them the opportunity to refine their skills at both visual and verbal research presentation.

Workshops throughout the program explored a variety of research-related skills, including analyzing manuscripts, formulating scientific questions, designing experiments, preparing posters, and more. In addition to the undergraduate cohort receiving valuable training, by developing these workshops, the graduate students and postdoctoral fellows gained

the opportunity to practice their teaching and presentation skills and collaborate with one another on workshop content. The workshop leaders have also become a resource for the USRP cohort for broader career and research advice, expanding the students' network of colleagues at Stanford.

Stanford Bio-X has also created a variety of additional programming to support and enhance the virtual summer research experience. Recognizing that data science, bioinformatics, and computational work have only become more valuable in a time of social distancing, we developed a **programming and statistics bootcamp** to give our students an academic and professional edge. A **wet lab technique training series** taught specific wet lab techniques through weekly group discussions led by experienced researchers so that students will be prepared once they can work in labs again. A series of **journal clubs** facilitated critical thinking among the students as they worked in small groups and led intellectually rigorous discussions regarding recent publications, innovations, and challenging scientific problems. Similar to the **workshops**, these new educational programs for the cohort offered 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. In a year so fraught with changes and uncertainty, we were 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.

Bio-X also provided additional opportunities for the undergraduate students to discuss their progress with one another and the Bio-X team. **Peer share meetings** encouraged the cohort to share ideas and practice disseminating their research to peers from varying backgrounds, as well as helping them to network with one another. Our five senior-level undergraduate cohort leads, who have each completed a previous summer of Bio-X USRP training, conducted check-ins and hosted virtual social events to increase cohort unity and help keep the students connected across the world.

Bio-X remains committed to fostering a strong interdisciplinary training for these up-and-coming scientists, and we were excited to use our new and adapted curriculum to ensure that each of our undergrads had a fulfilling virtual summer which enhances their research skills and helps prepare them for future careers in science and medicine.

Funding for the support of our program was provided by generous contributions from the Paramitas Foundation, The Rose Hills Foundation, Pitch and Cathie Johnson, 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

2020 FACULTY TALKS FOR THE STANFORD BIO-X UNDERGRADUATE RESEARCH PROGRAM

June 24

Kathleen Sakamoto (Pediatrics - Hematology & Oncology), "Signaling pathways in the pathogenesis and treatment of blood diseases"

Erin Gibson (Psychiatry & Behavioral Sciences), "Mechanisms of myelination from development to disease"

John Pringle (Genetics), "Using a small sea anemone in the lab to learn about reef-building corals"

July 1

Jonas Cremer (Biology), "Bacterial growth dynamics in the human large intestine"

David Kingsley (Developmental Biology), "Fishing for the secrets of vertebrate evolution"

Ravindra Majeti (Medicine - Hematology), "Therapeutic Targeting of the Macrophage Immune Checkpoint CD47 in AML"

July 8

Carolyn Lee (Dermatology), "Identifying novel cancer genes in skin malignancies"

Sharon Pitteri (Radiology), "Exploiting aberrant glycosylation in cancer"

Raag Airan (Radiology), "Nanoparticle-mediated ultrasonic drug uncaging"

July 15

Roger Kornberg (Structural Biology), "Human chromosome structure"

John Huguenard (Neurology & Neurological Sciences), "Switching brain states in epilepsy"

Mary Hynes (Biology), "Widespread differential expression of 3' UTR and cognate coding region sequences in neurons and other tissues"

July 22

Hadi Hosseini (Psychiatry & Behavioral Sciences), "Connectomics: implications in health and disease"

Brian Kobilka (Molecular & Cellular Physiology), "Structural insights into G protein coupled receptor activation"

Benjamin Good (Applied Physics), "Statistical physics of evolving microbial communities"

July 29

Brian Hargreaves (Radiology), "Medical imaging for orthopedic injuries"

Carolyn Bertozzi (Chemistry), "Therapeutic opportunities in glycoscience"

Tony Wyss-Coray (Neurology & Neurological Sciences), "Young blood for old brains"

August 5

Kristy Red-Horse (Biology), "Development of the coronary vasculature of the heart"

Cara Bohon (Psychiatry & Behavioral Sciences), "Bridging the gap between neuroscience and clinical research in eating disorders"

Ron Davis (Biochemistry and Genetics), "How to initiate a research program on an unexplored major disease"

August 12

Andrew Fire (Pathology and Genetics), "Genetic change as an adventure"

Ivan Soltesz (Neurosurgery), "Organization and control of neuronal circuits"

Markus Covert (Bioengineering), "From single-cell heterogeneity to population behaviors: a systems approach"

August 19

Thomas Südhof (Molecular & Cellular Physiology), "Deconstructing synapse formation, one molecule at a time"

David Myung (Ophthalmology), "Bioengineered therapies for corneal reconstruction and regeneration"

Thomas Clandinin (Neurobiology), "Dissecting the architecture of visual processing circuits in *Drosophila*"

August 26

Frank Longo (Neurology & Neurological Sciences), "Modulating p75 neurotrophin receptor signaling as a therapeutic strategy for Huntington's disease"

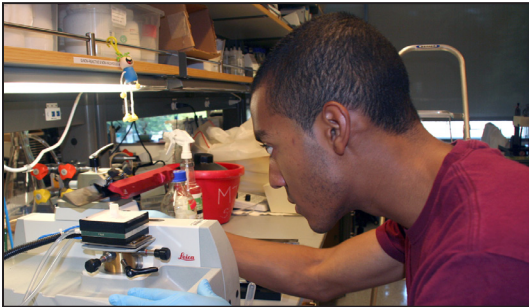
Shirit Einav (Medicine - Infectious Diseases and Microbiology & Immunology), "Capturing tissue heterogeneity to better understand viral infection and pathogenesis"

Vittorio Sebastiano (Obstetrics & Gynecology), "Dissecting the role of TBX1 in 22q11 deletion syndrome"

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 health-care companies
- started their own companies, including NeuCures, Diffeo, Taste, Epitior Biosciences, Fancy That, Benchling, Stronger Brains, and many other innovative startups at the intersection of science, technology, and health



2015 USRP Participant Kazuomori Lewis in Dr. Sarah Heilshorn's lab

Alumni Comments:



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

—2019 Student Mentor and 2018 USRP Participant Anaïs Tsai

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

—2019 USRP Participant Brandon Bergsneider

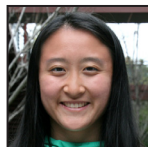


"It was truly amazing to spend two summers at Stanford working on research. I just graduated, receiving the Terman Scholastic Award, and [my] honors thesis including the research that I worked on over both summers... [won] the Kennedy Prize and Firestone Medal (as well as the CS department's Wegbreit Prize)! This would not have been possible without the Bio-X summer program."

—2018 and 2019 USRP Participant Maya Varma

"I really enjoyed my Bio-X experience, and I learned a lot through participating in the program. I found a love for research that I will continue pursuing in the future... My PI from that summer is still one of my mentors."

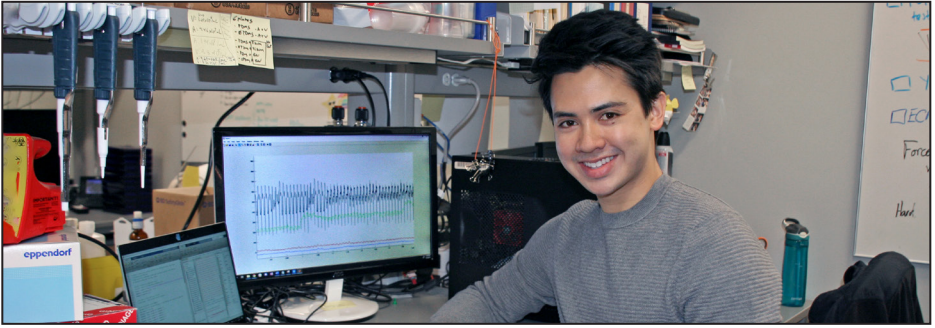
—2017 USRP Participant Michelle Xiao



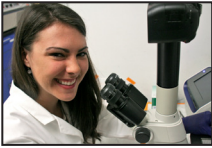
"The Bio-X program was a great way for me to start my research career by working with an amazing faculty member and graduate student. That summer research experience laid the foundation for my future research in oncology."

—2011 USRP Participant Julie Koenig

Recent Alumni Updates:

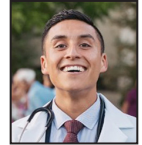


2018 Stanford Bio-X Undergraduate Summer Research Program participant and 2019 honorary fellow and student mentor Cody Carlton in the lab of Dr. Anson Lee.



Georgia Toal, 2015 cohort, is currently pursuing her MD at Stanford after joining Teach For America and then getting a Master's in Education. She received the Segal Americorps Education Award and was inducted into the Kappa Delta Pi International Honor Society in Education. She co-authored three publications directly related to her Bio-X summer research, as well as a fourth on other work in Dr. Dean Felsher's lab.

Joab Camarena, 2015 cohort (right), has co-authored papers published in *Molecular Therapy*, *Nature Medicine*, *iScience*, *Cell Stem Cell*, and *Nucleic Acids Research*. He has two patents underway, two co-first author manuscripts under review, and two co-author manuscripts under review. His Bio-X research is now approaching a clinical trial.



Aidan McCarty, 2016 cohort (left), is the co-founder and co-CEO of Be Heard, a tech startup designed to promote and streamline civic engagement by helping users contact and communicate with their government representatives. The company received funding from Samsung NEXT to provide a decentralized platform to secure personal information and identity while helping constituents reach their representatives.

Cindy Nguyen, 2017 cohort (right), co-authored papers in *Cell* and *Science* related to the CRISPR/dCas9 gene editing technology work she began in the Bio-X program. She received a Research Internships in Science and Engineering (RISE) Germany scholarship in 2018 and an NSF Graduate Fellowship in 2019. Cindy is pursuing a PhD in Electrical Engineering at Stanford.



Cody Carlton, 2018 cohort and 2019 honorary fellow and student mentor (above), works as a consultant at Oliver Wyman, a leading global management consulting firm, continuing to pursue his passion for modernizing healthcare through data-driven clinical innovation and translational research. Cody's Bio-X research led to Cody co-inventing a minimally invasive cardiac surgical method and co-authoring a paper in the *Journal of the American College of Cardiology*. Cody is passionate about community outreach for mental health, patient advocacy, and gender-violence prevention and education.



Chyna Mays, 2018 cohort (left), credits her time with Bio-X as assisting her with earning a 2019 summer internship with NASA's Office of Planetary Protection, where she designed an interactive training course delivered to NASA employees and affiliates, and contributed to a national student guide about Planetary Protection. For this work, she was awarded the "NASA Office of Planetary Protection and Office of Safety and Mission Assurance Recognition for Outstanding Support & Contribution to Field of Planetary Protection."

Sharon Huang, 2018 cohort (right), has continued the research she began during her time in the program as a junior at Stanford. She was named a Forbes 30 Under 30 Scholar in 2019 and won Biodesign NEXT Funding for her work on cardiac rehab for peripheral artery disease. Sharon is also on the Stanford Varsity Fencing Team and has helped to staff the Stanford Undergraduate Research Journal on campus.



Workshops on Research Skills:

In 2020, Stanford Bio-X hosted 7 workshops for the Undergraduate Summer Research Program cohort. The workshops were 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), were scheduled throughout the program to guide and prepare the undergraduate students. The workshop moderators also gained valuable teaching and presentation practice, as well as collaborating collectively to develop rigorous and meaningful workshop content. The session leaders also become a part of the student cohort's network, acting as a valuable resource for advice and future mentorship, both in terms of the topics covered and the students' future careers.



Dr. Aram
Raissi

Stephan
Eismann

Caitlin
Maikawa

Alec
Tarashansky

Chunzi
Liu

Dr. Rachel
Agoglia

Adele
Xu

Annina
Sartor

Anna
Elleman

Strategies for Reading, Analyzing, and Organizing Scientific Literature

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

Practical Tools for Research

In this workshop, Caitlin discussed how to stay organized while doing research and how to leverage digital tools to do this. Caitlin addressed the importance of lab notebooks and good record-keeping practices, discussed how to organize papers that students read, and then dove into brief overviews of other specific tools that are available free or through Stanford.

Visual Abstracts: Creating and Presenting Beautiful Posters

For students who wanted to learn how to make an eye-catching poster or were curious about how to present a poster in a concise fashion, this workshop covered the process of making and presenting a beautiful poster while conveying the key scientific concepts. Alec and Chunzi helped students visualize their thought processes and gave tips for how to successfully present their research story by the end of their summer research experience. Attendees were also encouraged to send any poster drafts to Alec and Chunzi for feedback and further discussion.

Setting and Achieving Goals

A key question for the cohort was: What does it take to have a fun and productive research experience? Skills like goal-setting, time management, and efficient communication are often just as important as technical training. In this workshop, Rachel and Adele discussed how students can effectively set goals for their research projects as well as strategies for staying on track with their goals. Rachel and Adele focused on how best to manage time and shared tips for productive communication between students and their mentor(s) to help make their projects a success.

Figure Design and Data Visualization

In this workshop, students learned how to visually represent the data that they collect during their research. Annina shared general guidelines about presenting data and managing space, demonstrated different ways to represent a dataset to achieve a specific goal, and discussed the design of Powerpoint Slides to support verbal presentations and guide viewer focus.

Oral Presentations

A key aspect of doing a research project is the ability to communicate your work to others. In this workshop, Annina and Caitlin provided instruction regarding presenting a research project verbally, both in the context of giving a group meeting-style presentation and talking at a poster session. They also helped students to develop an 'elevator pitch' summary of their work.

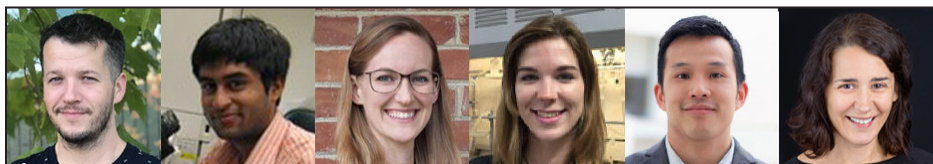
Abstract & Proposal Writing

In this workshop, Anna discussed how to write clear, concise abstracts and research proposals. By the end of the session, students gained an understanding of what makes a successful abstract/proposal, as well as a template/set of guidelines for writing about their own research ideas.

Wet Lab Technique Training Series:

This summer, Stanford Bio-X also hosted weekly wet lab technique trainings for the cohort, to offer background, practical instructions, and demonstrations of wet lab skills, preparing them for future in-person research.

Students were provided with programming to watch videos, learn protocols, and read up on methods for these wet lab techniques, 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, gained valuable opportunities to hone their teaching skills, and engaged in interactive scientific discussions with undergraduate students.



Dr. Justin
Trotter

Nimit
Jain

Dr. Amber
Nabet

Kerry
Betz

Dr. Ritchie
Chen

Dr. Maja
Djurisc

Achieving Mastery of Western Blotting

The ability to detect and quantify protein levels is a skill required in most life science labs. In this training, Justin discussed some protein basics, including how they are isolated and studied using Western blotting. Students left the session with a box full of tips and tricks ready to be implemented as soon as they can return to benchwork. Justin also discussed the importance of using proper controls and performing unbiased analysis to maximize the reproducibility of results.

Next-Generation Sequencing

Next-Generation Sequencing (NGS), developed over the past two or so decades, has revolutionized the detection and enumeration of some of the central macromolecules of life, DNA and RNA, providing an illuminating set of answers to many flavors of the fundamental question “What are we made of?”. This question underlies biology and its application to many aspects of medicine (pathogen detection, disease mutation identification, etc.), forensics, food safety and bioengineering. Nimit’s training session started with an overview of how we can sample a population of DNA or RNA molecules by NGS using Illumina sequencers. Nimit then conceptually surveyed a breadth of existing applications of NGS and discussed upcoming applications for biology-based research and medicine.

Thawing, Culturing, and Maintaining Human Embryonic Stem Cells

In this session, Amber covered the basics of thawing human embryonic stem cells from frozen stocks, then culturing and maintaining the ES cells in specialized media. Amber discussed in particular considerations of ES cell culture compared to the culture of more commonly-used immortalized cell lines, such as HeLa or HEK293T cells.

Gene Editing of Human Embryonic Stem Cells to Tag Endogenous Proteins

CRISPR/Cas9 gene editing has transformed the world of biology research and has made it easier and more efficient than ever to genetically edit human embryonic stem cells. In this training, Amber discussed the introduction of fusion tags into the endogenous locus of a protein of interest, including the overall design strategy of targeting constructs, the cell culture protocols used to introduce all of the components into the ES cells, and then led a brief discussion of the characterization and validation steps necessary.

Practical Chromatography Techniques for Separations

In this training, Kerry presented the basics of chromatographic separations and their applications in a variety of fields including analytical chemistry, biochemistry, organic chemistry, and beyond. Much of chemical-based science relies on the proper separation and purification of compounds of interest, including small molecules, proteins, sugars, nucleic acids, and more. Kerry presented on the theory behind these separation techniques as well as a number of ways in which this powerful method is applied to research across disciplines. Students gained an understanding of how chromatographic separations can be applied in their work, what types of mixtures can be separated, and an improved understanding of purification science.

Mapping Biology *in situ* through Chemical Transformation of Tissue

The visualization of intact tissue, from whole organs to entire organisms, enables the mapping of constituent molecules and cells within their native environment. The past 8 years have seen a rapid progression in new methods for high-resolution volumetric imaging of biological systems by transforming tissue, which naturally scatters light, into transparent samples by homogenizing the tissue's index of refraction. In this talk, students learned the historical progression of methods for tissue clearing, and the theoretical concepts that allow opaque samples to be rendered transparent. Ritchie also covered experimental techniques that highlight powerful new approaches to use proteins, fluorescent tracers, and nucleic acids to map neural circuits in their entirety. From this wet lab technique training, students also gained an understanding of hydrogel tissue chemistry, and learned how it can be adapted to map features in biological systems to understand the molecular changes that occur between health and disease.

Opsins and Applications in Neuroscience

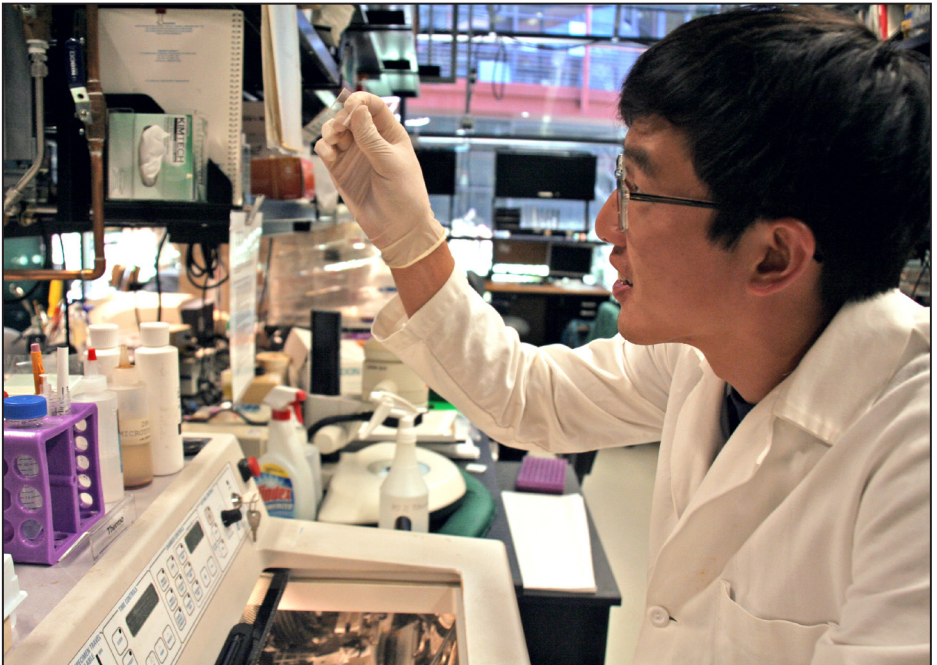
Microbial rhodopsins are light-activated ion channels or pumps, and, when expressed in neurons, enable control of neuronal activity with light. For this training, Ritchie highlighted various optogenetic tools for both neural excitation and inhibition and discuss their applications in systems neuroscience—from uncovering the circuit basis underlying behavior to clinical applications. From this presentation, students learned how optogenetics is currently performed and how it is used to understand brain function.

Cell Structure Studies Using Confocal Microscopy: Dendritic Spines and Learning

Cells change their shape in response to different stimuli. In mature neurons, the change in structure is most frequently observed at the level of dendrites and dendritic spines, a change thought to be a structural trace of novel learning. In this training, students learned about different mouse transgenic lines used for neuron-specific labeling that enable us to image dendritic spines, as well as non-genetic labeling techniques. Maja shared a demonstration of the tissue preparation that is necessary for fluorescent confocal imaging, and a basic operation of a confocal microscope.

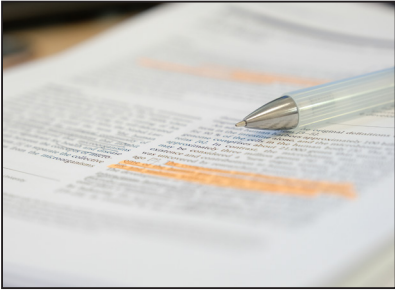
Brain Slices: A Neurophysiology Workhorse Facing “Age Discrimination”

Acute brain slices have been 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 training, students learned about the challenges of preparing acute brain slices from adult and aging animals due to excessive hypoxic damage. Maja discussed methods to maintain the sliced brain tissue alive for hours even from animals used for neurodegeneration studies.



Alan Wei, 2017 cohort, completed his Stanford Bio-X summer research training in Dr. Carla Shatz's lab

Journal Clubs:



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 has met with smaller groups of our students at regular intervals. These meetings have provided 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.



Stanford Bio-X Data Analysis Bootcamp:



With data science increasingly becoming a field of interest with numerous applications to research, this year Stanford Bio-X offered a rigorous Data Analysis Bootcamp for a number of our students. Designed by Professor Susan Holmes and led by Dr. Claire Donnat and graduate student James Li, the bootcamp has explored statistics for heterogeneous biological data using R and many Bioconductor packages, and has included topics such as simulations, mixture models and variance stabilization, and networks and microbiome data. These extremely useful and relevant skills will help to empower students both in their current summer projects and for their future careers. The bootcamp has also provided Claire and James with beneficial teaching experience and a strong connection with the undergraduate students.

2020 Stanford Bio-X Undergraduate Summer Research Program Participants:

Oluremi Akindele, Bioengineering

Mentor: Monther Abu-Remaileh (Chemical Engineering)

Defining the Molecular Basis for Common Hallmarks of Neurodegeneration in Lysosomal Storage Disorders and Age-Associated Neurodegenerative Diseases

Lysosomal dysfunction is known to contribute to the onset of many of age-associated neurodegenerative diseases, and many lysosomal storage disorders are indicated by neurodegeneration found in these age-associated neurodegenerative diseases. The shared pathophysiologies of the two disease types lead us to investigate whether they share any common pathways. Remi will be identifying differentially expressed genes common to lysosomal storage disorders and neurodegenerative diseases using mRNA expression datasets to gain further insights into the role of lysosomal dysfunction in these diseases.



Namitha Alexander, undeclared

Mentor: Frank Longo (Neurology & Neurological Sciences)

Genetic Relevance of Neurotrophin Receptors in Huntington's Disease

Huntington's disease (HD) is a neurodegenerative disorder that causes expression of a mutant huntingtin (mHtt) protein. Currently, disease-modifying therapies for HD do not exist. The Longo laboratory has developed a small molecule that binds to a specific neurotrophin receptor which was observed to reduce clusters of mHtt, or aggregates, that are prevalent in neurodegeneration in an HD mouse model. To confirm the positive results of this small molecule and investigate its mechanisms, Namitha will use another HD mouse model to observe the molecule's effects on mHtt and on proteins related to autophagy, the process of degrading unwanted proteins. This work is significant to understanding the link between the neurotrophin receptor and autophagy in the context of neurodegenerative diseases.



Stephanie Andersen, Computer Science

Mentor: Melanie Hayden Gephart (Neurosurgery)

Functional Dissection of the Meningeal Brain Tumor Niche Using Single-Cell RNA Sequencing

Leptomeningeal disease (LMD) is the most aggressive type of brain metastasis that patients with triple negative breast cancer (TNBC) have a high risk of developing. LMD is rapidly fatal, and patients have limited treatment options. Stephanie's project will use bulk and single-cell RNA sequencing data to compare the differential gene expression between healthy and LMD-affected meninges in order to better characterize how transcriptional changes can affect diffuse TNBC growth into the leptomeninges and cerebral spinal fluid, and how they may facilitate the spread of LMD.





Peyton Freeman, 2020 cohort, has completed her Stanford Bio-X summer research training with Dr. Fan Yang

Courtney Anderson, Biology

Mentor: John Pringle (Genetics)

Identifying the Pathways by which Chemicals Found in Common Sunscreens Induce Coral Bleaching and Death

Sunscreens contain chemicals, such as oxybenzone, whose ecotoxicology on coral reefs is understudied but has raised enough concerns for bans to be enacted. Many stressors can disrupt the essential symbiotic relationship between coral polyps and their symbiotic algae (a process called coral bleaching), but the cellular and molecular mechanisms behind chemical-induced bleaching are not well understood. Using the small anemone *Aiptasia* as a model system and several different assays, Courtney will investigate the toxicity of various common sunscreen ingredients (such as avobenzene and titanium dioxide) and the pathways associated with *Aiptasia*'s natural response mechanisms against chemical stress.



Tabitha Bandy-Vizcaino, Mechanical Engineering

Mentor: Joseph Woo (Cardiothoracic Surgery)

Flexible Variable Annulus

Degenerative mitral regurgitation describes a condition in which blood leaks backwards into the left atrium during the ejection phase of the cardiac cycle. This occurs because the mitral valve does not seal properly when the left ventricle of the heart is ejecting into the aorta. If this condition is left untreated, heart failure can occur. Tabitha's research aims to develop a device that creates a dilated mitral valve, which will be used in the Woo Lab's left heart simulator to mimic and analyze degenerative mitral regurgitation. Data collected from the simulator can elucidate better methods of treating this deficiency.

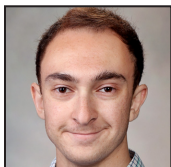


Tomas Bencomo, Computer Science

Mentor: Carolyn Lee (Dermatology)

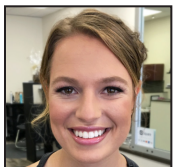
Investigating RAC1-Associated Prognostic Biomarkers for Invasive Melanoma

Current staging guidelines for melanoma are not sufficient to accurately identify patients at high risk of metastatic recurrence. The signaling protein Rac1 plays a vital role in melanoma metastasis, but the molecular factors that interact with Rac1 are poorly understood. Tomas's research will use the Rac1 interactome, the whole set of molecular factors that interact with Rac1, to develop a machine learning model that predicts metastasis and identifies potential drug targets. Tomas's work in the Lee lab will use statistical learning techniques to discover novel drug targets to treat metastatic melanoma and help clinicians better identify high-risk patients for adjuvant therapy.



Jules Brunello, Biology**Mentor: Justin Du Bois (Chemistry)****Expanding Access to Allylic Amines through C-H Amination**

The Du Bois lab uses chemical methods to construct a library of nitrogen-containing molecular probes, which are designed to investigate the function and dynamics of sodium channels in neuronal signaling and neuropathic pain. Juliana's research will focus on creating a method to incorporate nitrogen into molecules of considerable value to synthetic and biological chemists. These targets are difficult to access using currently-known methods: this new method has the potential to facilitate better access to natural products including antibiotics, antitumor agents in hormone-dependent cancers, and anti-HIV drugs.

**Hana Buabbas, Biology****Mentor: Sarah Heilshorn (Materials Science & Engineering)****Bio-Mimetic Recombinant Proteins for Peripheral Nerve Injury**

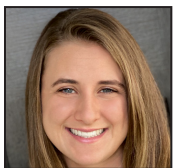
Current therapies for treating peripheral nerve injury are severely lacking: as few as 50% of patients achieve full functional recovery. To address these limitations, the Heilshorn lab has proposed the design of a family of recombinant protein-based materials that can be optimized for bio-chemical and bio-mechanical signals. This summer, Hana will characterize and validate a new protein-engineered material for this family of hydrogels and fine-tune the protocol for its expression and chemical modification.

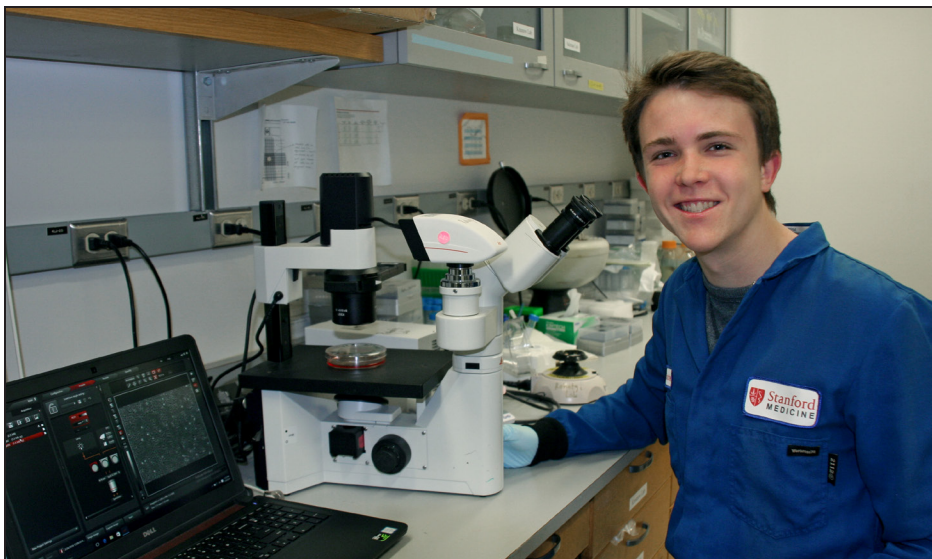
**John Butchko, Human Biology****Mentor: Stefan Heller (Otolaryngology - Head & Neck Surgery)****Cell Heterogeneity Within the Murine Inner Ear**

Although hearing loss in humans is, in most cases, permanent, avian species are able to regenerate cells in their inner ear that are responsible for hearing, allowing for recovery from damage. Currently, the mechanism by which this is achieved is poorly understood. John's project seeks to identify cellular markers capable of identifying cells that originated in the ear. Identification of these markers will aid in analysis of the cells involved in the regeneration pathway, with the aim of reproducing auditory recovery in the human ear.

**Madeline Dailey, Biology****Mentor: Aaron Gitler (Genetics)****Investigating the Role of Ataxin-2 in the Nuclear Transport of Splicing Factors in Neurons**

The goal of Madeline's work is to understand the role of Ataxin-2 as a protein implicated in the fatal neurodegenerative disorder amyotrophic lateral sclerosis (ALS), especially in its interactions with another ALS disease protein, TDP-43. Recent findings suggest that when TDP-43 is overexpressed in rodent neurons, it can result in the mislocalization of a class of nuclear proteins called splicing factors. Madeline will utilize image processing and analysis techniques to examine the localization of splicing factors in the absence of Ataxin-2 in hopes of shedding more light on the mechanistic pathology behind ALS.





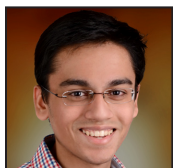
Collin Schlager, 2018 cohort, completed his Stanford Bio-X summer research training in Dr. Rajat Rohatgi's lab

Sid Suri Dhawan, Bioengineering

Mentor: Thomas Südhof (Molecular & Cellular Physiology)

A High-Throughput Deep Learning Pipeline for CRISPR gRNA Design to Screen a Library of Neuronal Adhesion Molecules

Understanding the logic that underlies synapse formation and specificity is integral to unraveling the molecular bases of our thoughts, memories, and behaviors. Synapse formation and regulation are orchestrated with high spatiotemporal precision in processes mediated by adhesion and signaling between transmembrane proteins. In his 2020 Stanford Bio-X research project, Sid will analyze a library of expressed neuronal transmembrane proteins and design repair templates to tag each protein using a novel CRISPR-based HDR strategy. In the future, these designs may be used to identify molecules of interest and track their localization at the synapse.



Ela Diffenbaugh, undeclared

Mentor: Lauren O'Connell (Biology)

Review of Research on Epigenetics of Nicotine in the Neonate Brain

Although it is understood that breastfeeding while smoking passes nicotine to babies, it is not yet understood how that process alters brain development and function. Nicotine affects the brain by binding to nicotinic acetylcholine receptors (nAChRs), which in turn upregulates the expression of nAChR subunits, which makes the user crave more of the drug. Ela's literature review will focus on the effects of nicotine exposure and how that influences DNA methylation and genetics to regulate the expression of nAChR subunits, thus providing a better understanding of how nicotine alters the infant brain.

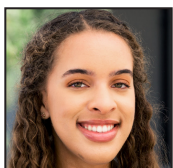


Alanna Dorsey, undeclared

Mentor: Luis de Lecea (Psychiatry & Behavioral Sciences)

Investigating the Impact of Female Sex Hormones on Sleep

Women experience nearly twice the risk of sleep problems that men do, particularly during hormonal changes such as puberty, pregnancy, and menopause. By reviewing recent advances in the role of sex hormones in sleep, Alanna's research will identify which aspects of sleep are most impacted by ovarian hormones and begin determining how this change in sleep relates to changes in brain activity. This will better elucidate how to treat women suffering from sleep disorders such as insomnia and sleep apnea, both of which can also increase the risk of metabolic and cardiac diseases.



Dante Dullas, Chemistry
Mentor: Lynette Cegelski (Chemistry)

Probing Atomic Contacts Between Phosphoethanolamine Cellulose and Curli in *E. Coli* Biofilms

Bacterial biofilms are responsible for pernicious, prolonged infections: they promote the persistence of bacteria and reduce susceptibility to host defenses, antibiotics, and environmental stressors. Dante's research will investigate the assembly and atomic interactions of specific unusual biopolymers responsible for the formation of *Escherichia coli* biofilms, using novel biochemical preparations and solid-state NMR spectroscopy analyses. This information will help him to investigate the mechanisms of biofilm inhibitors to better elucidate how to prevent the initial formation of biofilms and potentially eradicate preformed biofilms.



Sophia Fay, undeclared

Mentor: Maximilian Diehn (Radiation Oncology)

Interrogating Circulating Cell-Free RNA (cfRNA) for Non-Invasive Detection of Lung Cancer

Tumors release nucleic acids into the bloodstream in response to therapy, which can be identified from routine blood draws. Sophia will combine molecular biology, cancer biology, bioinformatics, and clinical research to determine if cell-free RNA in lung cancer patient plasma can help to non-invasively monitor treatment response and predict patient outcomes.

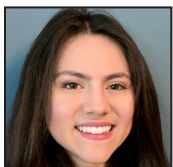


Victoria Franco, Psychology and Spanish

Mentor: Cara Bohon (Psychiatry & Behavioral Sciences)

Neural Correlates of Emotional Regulation and Cognitive Control in Adolescents with Binge-Eating

While the neural correlates of eating disorders are not yet fully understood, the body of research exploring the relation between patterns of neural structure and the function of binge eating in bulimia nervosa and binge eating disorder is growing rapidly. Although the onset of eating disorders is typically during adolescence, there is a lack of research in this subset of the population. Victoria's research aims to use functional magnetic resonance imaging (fMRI) tasks to examine the impact of cognitive control on emotion regulation, investigating the differences in functional connectivity within the prefrontal parietal network between adolescent females engaging in bingeing or purging and healthy controls. By exploring clinical implications and effective emotion regulation strategies, this work hopes to help those suffering from eating disorders.

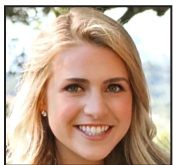


Peyton Freeman, Bioengineering

Mentor: Fan Yang (Orthopaedic Surgery and Bioengineering)

Enhancing Bone Regeneration Through Immunomodulation Using Microribbon Scaffolds

Cell membrane coating technology is a promising bio-mimicking material with versatile applications from removal of SARS Covid to target delivery and cancer immunotherapy. Peyton will be conducting a literature review in this field, and further exploring cell membrane application in immunomodulation for bone regeneration through immunostaining data analysis. Peyton's Stanford Bio-X research takes place at the interface of biomaterials, immunology, and tissue engineering, and will have broad impacts on designing cell membrane coated scaffolds with immunomodulatory functions to enhance bone regeneration.



Keely Fuller, undeclared

Mentor: Sharon Pitteri (Radiology)

Proteins in Interstitial Fluid for Distinguishing Benign from Malignant Breast Tumors

Screening mammography, currently the most widely-used tool for early breast cancer detection, faces the major challenge of a high false positive rate. A more sensitive biomarker may be found through the proteomic analysis of interstitial fluid from women with mammography-detected lesions. Keely will conduct these proteomic analyses and pairwise comparisons of interstitial fluid collected from both breasts of women with a suspicious finding on a mammogram, to aid in the discovery of a novel biomarker for the early detection of breast cancer.



Nicholas Gessner, Biology
Mentor: H. Craig Heller (Biology)

Sleep's Significance in Memory Consolidation



Sleep – a recurring state characterized by physical quiescence and a reduced response to external stimuli – is a highly conserved behavior observed throughout the animal kingdom. While sleep's function largely remains a mystery, an abundance of information corroborates its role in memory consolidation. Studies pioneered by the Heller Lab also implicate the circadian clock in memory formation, but the mechanism by which the circadian system modulates neural plasticity to afford the memory consolidation remains a novel research area. Nicholas will be conducting an exhaustive literature review of studies that might elucidate the relationships between circadian rhythms, sleep, and memory.

Bryanna Ogochukwu Godfrey, Human Biology

Mentor: Melanie Hayden Gephart (Neurosurgery)

The Effect of Tumor-Immune Interactions on the Systematic Tolerance of Triple Negative Breast Cancer Brain Metastases



Triple Negative Breast Cancer (TNBC) demonstrates high probability of spreading to the brain in cancer metastasis. The outcome of this process is often fatal, and there is a lack of FDA-approved therapies to help patients with these cancers. Immune manipulation has been associated with improved patient outcomes, but little is known about the immune interactions in TNBC. Bryanna will review clinical patient data and identify the best patients to use in this research to see how these interactions impact metastatic potential.

Mohammad Elmojtaba Gumma, Human Biology

Mentor: David K. Stevenson (Pediatrics - Neonatal & Developmental Medicine)

A Novel Point-Of-Care Device for Measuring Total Bilirubin in Infants at Risk for Newborn Jaundice



Jaundice, which is caused by the accumulation of the pigment bilirubin, commonly occurs in newborn infants during the first week of life. Infants who are not treated in a timely manner may develop bilirubin neurotoxicity, eventually leading to long-term motor deficits and hearing loss. Mohammad will be evaluating a prototypical point-of-care device called FINDER, interpreting blood assays that measure relative bilirubin levels and then creating data plots to gain insight into the accuracy of FINDER as a screening tool for identifying infants who are at-risk for bilirubin neurotoxicity.



Francesca Kim, 2020 cohort, has completed her Stanford Bio-X summer research training with Dr. Karl Deisseroth

Poojit Hegde, undeclared

Mentor: Ron Davis (Biochemistry and Genetics)

A Machine Learning Approach to the Morphological Classification of Red Blood Cells for the Diagnosis of Chronic Fatigue Syndrome

Myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) is a multi-systemic, debilitating illness affecting millions of people across the world, yet diagnosis remains difficult, and its etiology is poorly understood. Poojit will be inducing red blood cell (RBC) morphologies to train a machine learning classifier, in order to construct morphological profiles for patients and controls. These profiles will be used to develop a visual diagnostic for ME/CFS and better explain changes in RBC deformability and general cardiovascular differences in ME/CFS patients.



Lauren Hinkley, Human Biology

Mentor: Hadi Hosseini (Psychiatry & Behavioral Sciences)

Prefrontal Magnetic Resonance Spectroscopy Metabolites in Mild Cognitive Impairment

Mild Cognitive Impairment (MCI) is a transient state between the cognitive effects of normal aging and those of Alzheimer's disease (AD). The identification of a biomarker of MCI would be useful for tracking an individual's development from pre-AD to AD. Lauren will analyze data on cognitive abilities and neurometabolite concentrations, hoping to establish whether there is a relationship between MCI, neurometabolite concentrations in the prefrontal cortex, and cognitive abilities. This work will add to a larger, ongoing clinical trial funded by the National Institute on Aging that examines the effect of long-term cognitive training on neurocognitive function in patients with MCI versus healthy older adults.



Davey Huang, undeclared

Mentor: Carolyn Bertozzi (Chemistry)

Modeling Sugar-Microbiome Interactions in the Gastrointestinal Tract

The microbiome plays important roles in shaping our overall health, but there is a limited understanding of how to alter and regulate it. The goal of Davey's research is to investigate the roles that host sugars play in shaping the microbiome in the gastrointestinal tract. Using published human data linking host and microbial changes, this research will focus on the computational modeling of sugar-microbiome interactions.

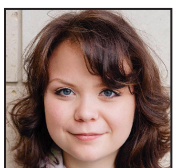


Alexis Ivec, Materials Science & Engineering

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

Using CRISPR-Based Systems in Epigenetic Screening for Advanced Gene Regulation

Developing CRISPR systems into tools for durably altering gene expression, such as silencing, could have many therapeutic outcomes. Directly editing the genome is challenging and may have unforeseeable implications. Employing epigenetic mechanisms that regulate gene expression could instead allow long-term silencing of genes without making irreversible modifications to DNA sequences. Alexis will be optimizing and testing a new technology within the CRISPR system that can silence genes in this way and developing a high-throughput screen to understand how to maximize silencing across a range of genes.

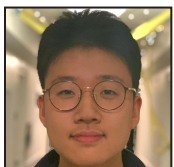


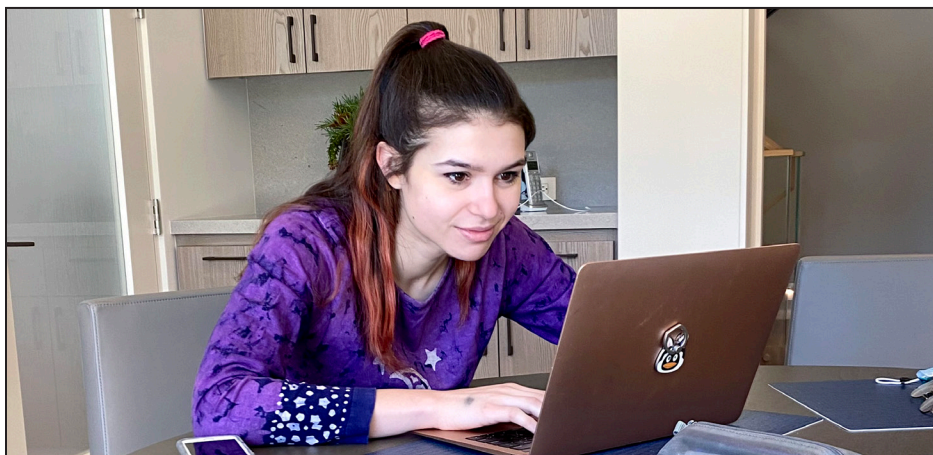
Kevin Jung, undeclared

Mentor: Kathleen Sakamoto (Pediatrics - Hematology & Oncology)

Repurposing Clinically Advanced Small Molecules for Diamond Blackfan Anemia Therapy

Diamond Blackfan Anemia (DBA) is a disease of childhood that results in the lack of red blood cell production. Current treatments for DBA have many short- and long-term side effects. The Sakamoto lab has previously showed that the protein Nemo-like Kinase (NLK) is abnormally active in DBA patients. Preliminary experiments from the lab have identified two molecules that inhibit NLK and can improve the production of red blood cells. Kevin will be conducting in-depth statistical analysis to further define the role of these two molecules in cell models of DBA, in the hopes of finding new therapies for this disease.





Psalm Pineo-Cavanaugh, 2020 cohort, has completed her Stanford Bio-X summer research training with Dr. Karen Parker

Francesca Kim, undeclared

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

Development of Interface for Minimally Invasive Deep Brain Optogenetic Stimulation

Optogenetics is a tool that utilizes light-gated ion channel proteins called Channelrhodopsins (ChRs) to achieve precise spatiotemporal control of neural activity. A lingering issue with this tool is the need for invasive surgeries and the implantation of materials required to deliver visible light to the brain. Francesca's project seeks to develop a minimally invasive optogenetic interface that allows for better mechanistic understanding of neuronal circuit function, with minimal damage to the brain. Francesca's goal is to demonstrate the possibility for deep brain optogenetics without the need for invasive implantation and direct deep brain viral injections.

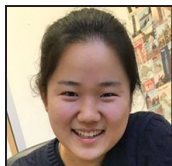


Gaeun Kim, Bioengineering

Mentor: Markus Covert (Bioengineering)

Curating and Modelling Gene Expression Regulation in a Whole Cell Model of *E. coli*

With the rapid, independent generation of biological data by research groups worldwide, there is a pressing need to evaluate the cross-consistency of these data, extract relevant biological parameters, and integrate them into models that form our understanding of cellular processes. With *E. coli* as a model organism, Gaeun will curate existing parameters for gene expression and use mathematical modelling techniques to build a sub-model for gene expression regulation and subsequent translation to the protein level. This research will expand on the Covert Lab's whole cell model of *E. coli* by more than 150 genes, enable predictions of cellular physiology in response to environmental changes, and contribute to an impactful pipeline that will advance the field of large-scale modelling.



Sayeh Kohani, Biomedical Computation and Economics

Mentor: Liqun Luo (Biology)

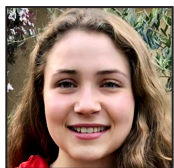
Molecular Mechanisms of Neuronal Wiring Specificity

Studying the mechanisms by which neurons are able to achieve wiring specificity is key to better understanding brain development. Sayeh's research focuses on unveiling novel wiring molecules and mechanisms that contribute to the formation of precise connections between neurons. Using the fruit fly olfactory circuit as a model, Sayeh has identified several novel wiring molecules through a genetic screen. This summer, she will use single-cell RNA sequencing data and analysis techniques to further investigate the spatial and temporal dynamics of wiring-molecule expression.

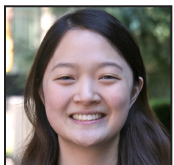


Josephine Elise Krieger, Biology**Mentor: Kristy Red-Horse (Biology)****Single-Cell RNA Sequencing of Coronary Vascular Endothelial Cells at Neonatal Stages**

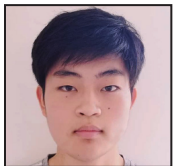
Coronary artery disease (CAD) obstructs essential blood flow to the heart and results in mortality or severe injury. In contrast to the adult heart, the neonatal mouse heart, including its coronary arteries, has a unique capacity to repair itself after injury. Josephine aims to characterize the neonatal heart's regenerative potential by using single-cell RNA sequencing techniques to investigate differences in gene expression between vascular endothelial cells at different neonatal stages. Understanding neonatal coronary artery development may contribute to the greater goal of repairing coronary arteries in the diseased adult heart.

**Tracy Lang, Human Biology****Mentor: Peter Jackson (Microbiology & Immunology)****Elucidating the Pathways Driving Adipogenesis**

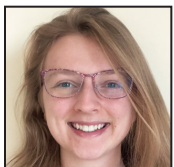
Tracy will be using bioinformatic analysis of a CRISPR screen and genomics and proteomics data to build models for how adipogenesis and the differentiation of fat cells work. Based on a genome-wide screen, Tracy will be analyzing data from a suite of public databases and integrating this data towards building hypotheses for additional directed experiments. This work will improve our understanding of new pathways driving differentiation.

**David Lee, undeclared****Mentor: David Kingsley (Developmental Biology)****The Genetic Basis of Common Skeletal Evolution in Sticklebacks**

The bony skeleton plays a key role in feeding, support, locomotion, and tissue protection in vertebrates. Species in different environments frequently evolve major differences in the size, shape, number, and density of bones. Although skeletal changes play a key role in both environmental adaptation and protection from predators and common diseases, the genetic and genomic basis of skeletal changes in wild vertebrate species are still poorly understood. David will examine this question by characterizing the genetic basis of interesting changes in bone density and dorsal spine number evolving in stickleback fish (*Gasterosteus aculeatus* and *Apeltes quadracus*).

**Lexi Linker, undeclared****Mentor: Ivan Soltesz (Neurosurgery)****Characterization of Inhibitory Connectivity in Healthy and Epileptic Brain Circuits**

Diverse types of inhibitory interneurons control the rhythm and excitability of cortical networks, and a dysfunction of these neurons is one of the main causes behind epilepsy. Lexi's Stanford Bio-X research will focus on developing and verifying tools to study the specific patterns of synaptic connections of the interneurons in the hippocampus, to better understand changes to the inhibitory circuitry in animal models of epilepsy.

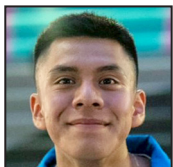
**Christine Liu, Computer Science****Mentor: John Huguenard (Neurology & Neurological Sciences)****Closed-Loop Model to Predict Epileptic Seizures using Machine Learning in Real Time**

Epilepsy is one of most common neurological disorders, affecting more than 65 million people worldwide. While most patients with epilepsy have their seizures controlled by medication or surgery, more than 30% continue to have spontaneous and debilitating seizures and would greatly benefit from a system to predict seizures with sufficient warning time. Christine's research seeks to develop a closed-loop seizure prediction system using machine learning models and data from electroencephalograms, in order to accurately predict seizures in real time.



Darwin Luna, undeclared

Mentor: Jun Ding (Neurosurgery and Neurology & Neurological Sciences)
Understanding the Role of Hippocampal Plasticity in Learning



Alcoholism, also known as alcohol use disorder (AUD), is a debilitating disease. Currently, there are only three treatments approved by the FDA, and, unfortunately, these treatments do not work for all alcoholics. In order to develop better therapeutics, we must understand the cellular and synaptic mechanisms of ethanol reward and learning. Using histology and data analysis, Darwin hopes to provide a clearer account of the role of learning in the striatum, an area in the brain involved in alcohol reward. The mechanistic insight gained from these studies could help advance novel treatment strategies for alcohol use disorder.

Daniel Martinez-Krams, undeclared

Mentor: Ravindra Majeti (Medicine - Hematology)

Characterizing In Vitro Cell Culture of Acute Myeloid Leukemia Patient Samples for Drug and Genomic Screens



Acute myeloid leukemia (AML) is an aggressive cancer of the bone marrow with poor patient outcomes. The most important questions that scientists need to answer about AML biology are hampered by our inability to successfully culture patient samples in the lab. Daniel's research seeks to identify the features of effective patient sample cultures to facilitate future drug and genomic screens.

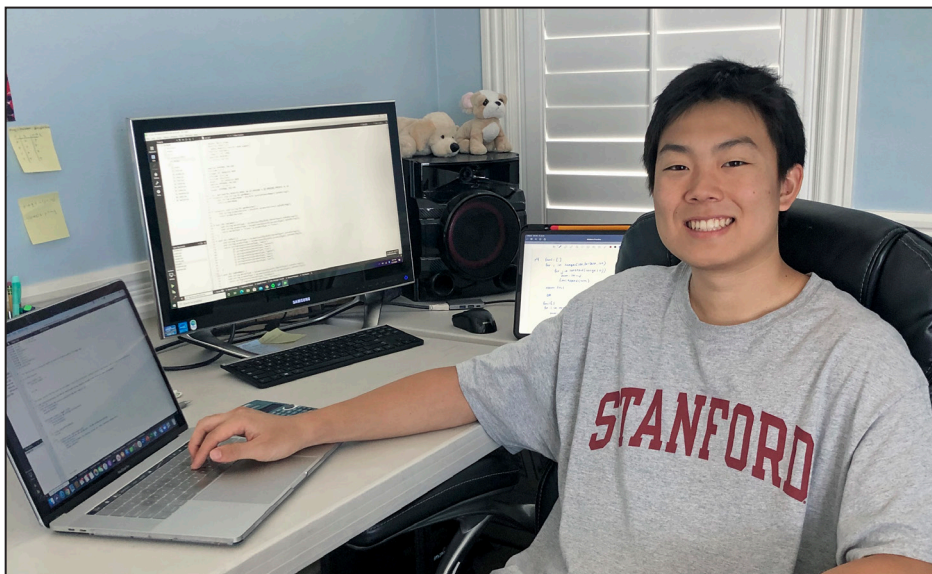
Rachana Mudipalli, Bioengineering

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

Characterizing Value-Encoding in Genetically Defined Cell Types in the Orbitofrontal Cortex



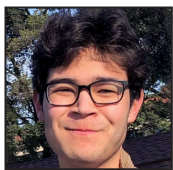
Animal environments present a variety of stimuli with differing motivational values. Animals must evaluate these different stimuli and decide which to pursue. Prior studies have identified neurons in the orbitofrontal cortex whose firing rates correlate with the value of different stimuli offered to an animal. However, how these neurons map onto anatomically or genetically defined cell types remains unknown. Rachana seeks to analyze single cell neural activity data, recorded from mice responding to differentially valued environmental stimuli, to characterize how value is represented in genetically defined cell types in the orbitofrontal cortex.



Andrew Song, 2020 cohort, has completed his Stanford Bio-X summer research training with Dr. Scott Delp

Saket Myneni, Biology**Mentor: Tony Wyss-Coray (Neurology & Neurological Sciences)****Identifying the Mechanism of Oligodendrocyte Rejuvenation Following Exposure to Young Cerebrospinal Fluid**

Oligodendrocytes provide support and insulation to axons in the central nervous system, making them essential for proper cognitive function, which declines with aging. The Wyss-Coray lab's work has revealed that transfusing cerebrospinal fluid (CSF) of younger mice into older mice has beneficial effects on the proliferation and differentiation of oligodendrocytes. Saket's research will study the underlying mechanisms of this effect through a bioinformatics approach, in an attempt to identify potent protein candidates in CSF which could potentially be used to develop therapeutics that target cognitive decline related to age and neurodegenerative diseases.

George Kenji Ikaika Nakahara, undeclared**Mentor: Thomas Südhof (Molecular & Cellular Physiology)****Investigating How Astrocytic Neurexin-1 Instructs Synapse Development**

Genetic variation in the gene that encodes for Neurexin-1, a protein well known for its role in synapse development, has been implicated in cases of autism spectrum disorder, schizophrenia, and Tourette syndrome. However, our understanding of Neurexin-1 function and regulation in diverse cell types in the brain is limited. George's research will investigate how astrocytes, a major non-neuronal cell type in the brain, utilize Neurexin-1 to regulate synapse development, thus elucidating the role of this protein in developmental disorders.

Lorena Orozco, Human Biology**Mentor: Brian Kobilka (Molecular & Cellular Physiology)****Measuring the Conformational States and Dwell Time of the Mu-Opioid Receptor**

Drugs which target the opioid receptor for analgesic, or pain-relieving, effects can have side effects that include respiratory suppression. Analgesia occurs when the receptor couples to a protein in the cell called a G protein, and respiratory suppression occurs when the receptor couples to a protein called arrestin. Lorena will measure the conformational changes of the opioid receptor, hoping to determine which changes in the receptor lead to coupling to the G protein, and which changes lead to respiratory suppression. This will provide insight into molecular mechanisms for the action of opioid drugs.



Mohammed Osman, Symbolic Systems

Mentor: *Thomas Clandinin (Neurobiology)*

Investigating the Role of Recurrent Connectivity in Visual Processing

Feedback and recurrent connectivity are ubiquitous but poorly understood features of the nervous system, and they underlie state-of-the-art machine learning models for speech recognition, robotics, and other tasks. As such, demystifying the functional role of recurrence could greatly contribute to our understanding of the brain and help us engineer better AI systems. To that end, Mohammed will be using computational models to investigate how recurrent connections contribute to motion detection in the fruit fly visual system.



Sophie Jasmin Parsa, Computer Science

Mentor: *Mary Hynes (Biology)*

Biological Functions of the 3'UTR in Tumor Development

Over the last decade, it has been shown that RNA is not simply a messenger, as RNA itself can critically regulate many biological processes. The Hynes lab and others have identified the widespread, stable, and non-random expression of 3 prime untranslated regions of mRNA (3'UTR) sequences even in the absence of their coding regions (CDS). They are now investigating the biological role of such "isolated" 3'UTRs in early neural development. Sophie will expand on this developmental role proposed by the Hynes Lab to examine the role of 3' UTR sequences in the tumor development of skin cancer, as well as other common cancer types. Sophie will be using open source RNA-seq expression cancer data sets and conduct analyses of gene categories and cell clustering to potentially identify unique signaling pathways that are pertinent to this study.



Sergey Pavlov, Biology

Mentor: *Sharon Pitteri (Radiology)*

Glycoproteomic Analysis of a Patient Derived Renal Cell Carcinoma Xenograft Mouse Model for Cancer Early Detection

Renal cell carcinoma (RCC) has a poor prognosis for most patients, unless it is detected at an early stage. To facilitate the discovery of novel blood-based protein biomarkers for early detection of RCC, Sergey will use patient-derived xenograft (PDX) mouse models and analyze liquid chromatography-mass spectrometry data on the mouse serum and tumors, in order to identify and characterize glycoproteins that could serve as potential biomarkers for RCC.



Lejla Pepic, Biology

Mentor: *Joseph Wu (Medicine - Cardiovascular Medicine and Radiology)*

Induced Pluripotent Stem Cell (iPSC)-Derived Exosomes as Biomarkers of Cardiomyopathy

Cardiomyopathy is a disease of the heart muscle that can cause heart failure, the inability of the heart to meet the metabolic demands of the body, and sudden cardiac death. Many genetic mutations are known that predispose an individual to cardiomyopathy, but a large number of cardiomyopathy cases are idiopathic or have variable penetrance, meaning that biomarkers which can aid in detecting and evaluating the severity of cardiomyopathy are needed. Lejla will analyze the non-coding RNAs in secreted, membrane-bound vesicles called exosomes from iPSC-derived cardiac cells, using a combination of large-scale sequencing and dry-lab bioinformatics approaches. Her work will test the hypothesis that non-genetic factors such as long non-coding RNA might be harnessed as biomarkers to diagnose cardiomyopathies.

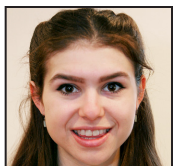


Psalm Pineo-Cavanaugh, Human Biology

Mentor: *Karen J. Parker (Psychiatry & Behavioral Sciences)*

Oxytocin Disruption in Hypothalamic and Pituitary Disorders: A Review of the Literature and Theoretical Framework

Social deficits have recently been identified in some patients with hypothalamic and pituitary (HPIT) disorders. Oxytocin, a neuropeptide involved in mammalian social functioning, may underlie these impairments. Psalm aims to compile a comprehensive review of pre-clinical and clinical literature to elucidate how damage to the hypothalamus and pituitary in individuals with HPIT disorders alters oxytocinergic systems and how this may relate to social functioning in this population.





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

Matthew Prospero, Bioengineering

Mentor: Vittorio Sebastiano (Obstetrics & Gynecology)

Dissecting the Transcriptional Role of TBX1 in Human Pharyngeal Endoderm



22q11 Deletion Syndrome is the most common chromosomal deletion syndrome and affects 1 out of 2000-4000 newborns, resulting in a number of phenotypic abnormalities that severely impair the life of the patients and often result in premature mortality. The various deletions in this syndrome encompass 30-50 genes, but the loss of a single copy of the TBX1 gene is sufficient to recapitulate most symptoms related with larger deletions. This suggests that TBX1, which has an important role in the formation of tissues and organs during embryonic development, plays a fundamental role in the disease. The goal of Matthew's Stanford Bio-X research is to investigate the molecular role of TBX1 in human stem cells, using a highly multidisciplinary approach that encompasses stem cell biology, genomics, and bioengineering.

James Reed, Biology

Mentor: Michelle Monje (Neurology & Neurological Sciences)

Examining Pediatric High-Grade Glioma with scRNA-seq



In pediatric high-grade glioma, interactions between neurons and malignant cells are highly relevant to tumor progression. Dissecting glioma cells' varied niches and microenvironmental interactions with neurons could therefore provide insight into this extremely deadly and aggressive cancer. James's project will use single-cell RNA sequence analysis to investigate glioma cell subpopulations and their potential roles in synapse formation and tumor progression.

Layton Rosenfeld, undeclared

Mentor: Benjamin Good (Applied Physics)

New Computational Tools for Measuring the Relationship Between Ecological and Evolutionary Changes in the Human Microbiome



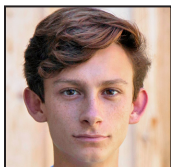
The composition of the human gut microbiome has been extensively studied at the species level, but much less is known about how the organisms in the microbiome evolve over time. Layton will develop computational tools that leverage publicly available sequencing data from human microbiomes to determine whether evolutionary changes within microbial species influence the ecological structure at the species level. The results of this analysis will have important implications for therapeutic interventions like fecal microbiome transplants to treat infections, as well as for broader efforts to understand how the microbiome affects human health.

Tristan Saucedo, Biology

Mentors: *Michelle Monje (Neurology & Neurological Sciences) and John Huguenard (Neurology & Neurological Sciences)*

Maladaptive Myelination in Epilepsy

Myelination, which insulates cells in the brain and enables fast transmission of information between neurons, is dynamic over the course of the human lifespan. A recent discovery is that changes in myelination can be driven by neuronal activity to support learning. However, this process might be subverted in diseases characterized by abnormal or excessive neuronal activity, such as epilepsy, which is defined by chronic seizures. Tristan will utilize neurophysiological and histological methods to determine whether abnormal myelination observed in rodent models of epilepsy contributes to disease severity, potentially illuminating a novel disease mechanism in epilepsy.

**Sofia Schlozman, Human Biology**

Mentor: *Robert Malenka (Psychiatry & Behavioral Sciences)*

Investigating Circuitry Accounting for MDMA's Addictive and Prosocial Effects

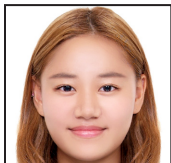
MDMA, or "ecstasy", is a drug of abuse with potential therapeutic benefits for conditions such as Post-Traumatic Stress Disorder. Because these benefits are thought to be rooted in MDMA's effects on sociability, engineering effective therapies requires separating MDMA's prosocial effect from its high abuse potential. Using whole-brain unbiased maps of neural activity and data analysis techniques, Sofia will compare activity maps generated in different drug-induced states in mice to isolate circuits that account for MDMA's addictive and prosocial effects. Her project will involve mentored use of several established software packages for image analysis, as well as formal instruction in relevant programming languages such as python and RL.

**Youngyoon Amy Seo, Biology and East Asian Studies**

Mentor: *David Myung (Ophthalmology)*

Treatment of Corneal Chemical Alkali Burns with Hyaluronic Acid Gel and CsA-Loaded Nanofibers, a Potential Effective Alternative Mode of Therapy for Corneal Chemical Burns

Youngyoon Amy's Bio-X summer research focuses on corneal injuries. In one project, she will analyze data from animal studies to see if integrating electrospun fibers with a particular peptide called cyclosporine A (CsA) would be a better approach to treat corneal chemical burns and suppress inflammation and neovascularization than CsA eyedrops, which can be diluted with tears and quickly washed out. In her second project, Amy will contribute to the data analysis and manuscript writing for another animal study in which crosslinked collagen hydrogels delivered mesenchymal stem cells to alkaline-burned rabbit corneas.



Maya Shetty, Biomechanical Engineering

Mentor: Brian Hargreaves (Radiology)

Hip Phantom Development for Mixed Reality-Guided Orthopaedic Surgery

Femoroacetabular Impingement (FAI) is a hip condition which causes pain and disability. Orthopedic surgery for this procedure can alleviate symptoms, but the procedure is challenging due to the way that the surgeon's limited view of the joint and the difficulty of removing bone properly to reduce pain. Maya's Stanford Bio-X research will involve the development of a mixed-reality system for intraoperative image-guided FAI surgery, in the hopes of aiding orthopedic surgeons during this complicated procedure.



Amol Singh, Computer Science

Mentor: Manu Prakash (Bioengineering)

Efficient Computational Pipeline for Accurate Diagnosis of Malaria and Other Infectious Diseases

Over the past 5 years, there has been no significant progress in reducing global malaria rates; instead, cases of malaria have increased. Amol will develop a series of computational pipelines to accurately detect and determine the concentration of the malaria parasite. By employing optics, signal processing, and machine learning techniques, he aims to identify key features for parasite staging/speciation and determine how to efficiently detect the parasites with a new low-cost high-throughput imaging platform that is battery-powered and can screen more than one million blood cells per minute.

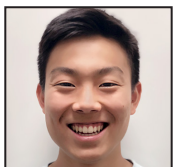


Andrew J. Song, Biology

Mentor: Scott Delp (Bioengineering and Mechanical Engineering)

Building a Machine-Learning Model to Predict the Peak Knee Adduction Moments in Patients with Knee Osteoarthritis

Knee osteoarthritis is a painful disease that affects the lives of over 20 million individuals in the United States. Although previous studies from Stanford have demonstrated that adjusting the walking patterns of patients with knee osteoarthritis can greatly reduce their pain associated with the disease, the current method of training these individuals requires expensive laboratory equipment. Using video from smartphones, Andrew's research will employ machine learning to develop a new method to predict the optimal way of walking in order for these patients to reduce knee loads and therefore pain. The success of this project will open the door to improving the rehabilitation of people with musculoskeletal diseases.

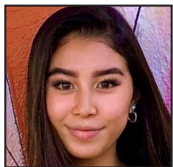


Marina Takehana, undeclared

Mentor: Anson Lee (Cardiothoracic Surgery)

Engineering an Epicardial Mapping and Ablation Device for Minimally Invasive Surgery in Patients with Ventricular Arrhythmias

Cardiac mapping and ablation have emerged as valuable tools for the treatment of heart rhythm disorders such as ventricular tachycardia; however, current techniques for mapping the epicardium are limited in their ability to accurately localize regions of arrhythmia. Tools that can better evaluate arrhythmogenic sites and offer precise localization of disease foci may lead to improved surgical intervention and therapeutic success. Marina will design and engineer a minimally invasive device that will enable patient-specific epicardial mapping during minimally invasive cardiac surgery, which will aid in the diagnosis of ventricular arrhythmias and improve ablation therapies.



Calvin Taylor, Bioengineering

Mentor: Anson Lee (Cardiothoracic Surgery)

MRI Assessment of Cardiac Fibrosis and Tissue Remodeling in Hearts with Atrial Fibrillation

Cardiac fibrosis has been implicated in an ever-increasing role in heart disease and can be both a cause and a consequence of atrial fibrillation. Calvin will attempt to develop non-invasive methods of assessing fibrosis, using MRIs of porcine hearts experiencing different stages of atrial fibrillation. These methods will allow him to study fibrotic tissue remodeling in atrial fibrillation and pave the way for routine assessment of fibrosis in clinical and research settings.





Tabitha Bandy-Vizcaino, 2020 cohort, has completed her Stanford Bio-X summer research training with Dr. Joseph Woo

Edward Tran, Bioengineering

Mentor: Calvin Kuo (Medicine - Hematology)

Enhancing Immunotherapy Response by Combinational Approach of Immune Checkpoint Blockade Using Organoids

Research has shown that implementing an immune checkpoint blockade to interrupt immune inhibitory pathways can facilitate a more robust immune response to cancer and improve cancer treatment, but its combinational approach still has to be optimized to enhance the efficacy. Edward's Stanford Bio-X summer research will assess if human tumor samples grown as 3-dimensional "organoids" can be used to optimize a combinational approach of immune checkpoint blockade in cancer immunotherapy.



Jennifer Vu, Human Biology

Mentor: Vinit Mahajan (Ophthalmology)

Utilizing Personalized Proteomics to Improve Diagnosis and Treatments for Vitreoretinal Diseases

Proteomics, the study of large-scale protein sets expressed in a region of interest, is transforming the field of ophthalmology. With the ability to analyze a proteome in the context of specific diseases, the Mahajan lab works to better understand protein expression patterns and identify therapeutic targets for eye diseases. Jennifer's research will use proteomics, biochemistry, and bioinformatics to explore the role of crystallins and other proteins in eye conditions, including lens-induced uveitis and infectious endophthalmitis, in the hopes of paving the way for better treatments for these diseases.

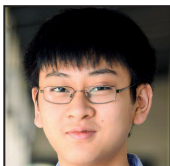


William Wang, undeclared

Mentor: Andrew Fire (Pathology and Genetics)

Developing a Strand Bias Assay to Detect Extrachromosomal DNA

DNA-dependent RNA polymerases (RNAPs) synthesize RNA from DNA and are critical enzymes for life. However, a few RNAPs have been demonstrated to exhibit an unusual ability to regenerate particular RNA templates directly from RNA, without any DNA involvement. This could potentially explain the multigenerational inheritance of RNA-based genetic information in cellular organisms, such as the propagation of certain RNA pathogens. To assess whether RNA replication by RNAPs is widespread in nature, William aims to employ an interdisciplinary approach to test the capability of RNAPs to regenerate RNA from RNA in a variety of biological contexts, to better understand this phenomenon and its effects.



Emmanuelle Williamson, undeclared

Mentor: Michelle Monje (Neurology & Neurological Sciences)

Unraveling Neuronal Activity-Mediated Glioma Growth

High-grade gliomas are aggressive brain tumors, the progression of which is regulated by neuronal activity and the microenvironment of the brain. It has been observed that the depolarization, or the shift in electrical charge within a cell, of glioma membranes promotes the proliferation of glioma tumors, through unknown signaling mechanisms. Emma hopes to identify the pathways activated by this glioma membrane depolarization that regulate the growth of glioma cells. This research could elucidate neuronal activity-mediated glioma growth and novel therapeutic targets for high-grade gliomas.

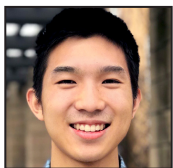


Vincent Xia, Chemical Engineering

Mentors: David Myung (Ophthalmology) and Gerald Fuller (Chemical Engineering)

Understanding Human Tear Film Fluid Dynamics for Dry Eye Therapeutics

Laboratory models of the human tear film can help us better treat dry eye. Yet despite the tear film's pivotal role in dry eye syndrome, we are still deficient in our understanding of its complex fluid dynamics in response to therapeutics. Vincent aims to improve upon our current understanding of tear film "breakup" – the principal mechanism that characterizes dry eye – to improve our ability to treat dry eye syndrome.



Eunice Yang, Computer Science

Mentor: Ami Bhatt (Medicine - Hematology and Genetics)

Analyzing the Functional Role of *Akkermansia muciniphila* in the Gut Microbiome Using a Multi-Omics Approach

The complex network of commensal host-microbe interactions in the human gut is critical to the maintenance of proper immune function. Eunice will be investigating the role of *Akkermansia muciniphila* (*A. mucin*) in the gut microbiome. *A. mucin* is a significant microbe implicated in a broad array of immune-related disorders, including autoimmune diseases, inflammation, and cancer. This project will involve developing computational tools to characterize the transcriptional responses of *A. mucin* to environmental stresses commonly found in the gut. By uncovering the role of this microbe, Eunice's work will support further research into the therapeutic potential of microbiome manipulation for graft-versus-host-disease prevention.



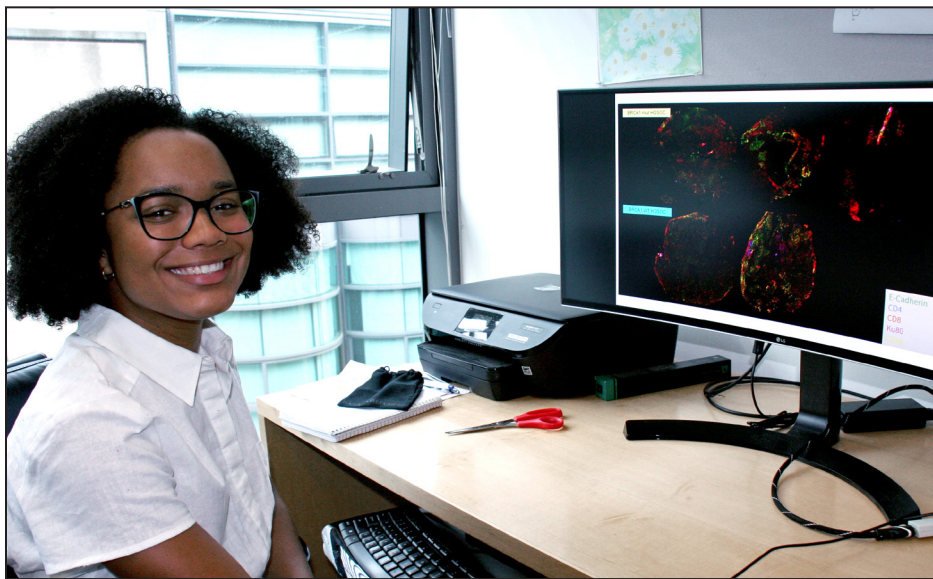
Raymond Yin, undeclared

Mentor: Ravindra Majeti (Medicine - Hematology)

Characterization of Mutations in Human Acute Myeloid Leukemia in Octogenarians

Raymond's research focuses on understanding the differences in the presentation of acute myeloid leukemia (AML) between patients greater than 80 years of age and those who are younger. He aims to perform data analysis on clinical datasets to compare the patterns of mutations among various age groups of patients. The data that Raymond generates will contribute to the development of better therapeutic treatment strategies for elderly patients with AML.



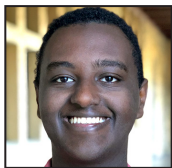


Alexis Lowber, 2019 cohort, completed her Stanford Bio-X summer research training in Dr. Wendy Fantl's lab

Ezra T. Yoseph, Human Biology

Mentor: May Han (Neurology & Neurological Sciences)

Role of Central Nervous System Pericytes in Demyelination and Repair

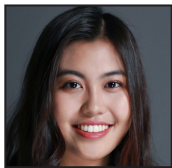


Breakdown of the blood-brain barrier and subsequent neuroinflammation is a major hallmark of demyelinating disorders like Multiple Sclerosis (MS). At this time, little is known about the role that pericytes, cells which wrap around the endothelial cells that line capillaries and venules, play in maintaining the structural integrity of the blood-brain barrier. By analyzing pericyte-deficient mice which are induced to mimic MS symptoms, Ezra hopes to elucidate the mechanism of demyelination and myelination repair in order to provide key insight into therapeutic agents for neurodegenerative diseases like MS.

Helena Zhang, Human Biology

Mentor: Michelle Monje (Neurology & Neurological Sciences)

Investigating the Role of BDNF-TrkB Signaling in Promoting Pediatric Glioma Progression



Pediatric high-grade gliomas (pHGG) are a devastating group of diseases, with a survival of 9-15 months. The Monje lab has demonstrated that neuronal activity is a key regulator of brain development and plasticity, and that a growth factor called brain-derived neurotrophic factor (BDNF) is one mechanism by which neuronal activity promotes glioma cell proliferation. BDNF is secreted in response to brain activity and plays numerous roles through its receptor, TrkB. Helena will try to determine to what degree BDNF is necessary for pediatric high-grade glioma growth, as well as whether targeting BDNF signaling in the tumor microenvironment by using TrkB inhibitors could be a potential treatment for this cancer.

Claudia Zimmerman, undeclared

Mentor: Jonas Cremer (Biology)

Oxygen Dependent Growth of Gut Bacteria



Gut bacteria are essential for our health, but their growth behavior within the large intestine is not well studied. In her project, Claudia will investigate the role of gases, specifically oxygen, as a growth factor of bacteria. To this end, she will use computer modeling to describe and mimic bacterial growth, under various conditions, within the intestine.

2020 Stanford Bio-X Undergraduate Summer Research Program Cohort Leads:

Foster Birnbaum, Biology and Computer Science

Mentor: Helen Blau (Microbiology & Immunology)

Investigating the Mechanism of Contractile Dysfunction in Genetic Cardiomyopathies



Many common genetic cardiomyopathies, such as Duchenne Muscular Dystrophy, are caused by mutations in genes involved in the function of the sarcomere, the fundamental unit of heart muscle cell contraction. Foster will leverage a human induced stem cell-derived cardiac model and state-of-the-art imaging and analysis techniques to study the mechanism by which these mutations disrupt contraction. Insights into this mechanism will aid in the development of more targeted treatments for genetic cardiomyopathies.

Jacob Greene, Biology

Mentor: Erin Gibson (Psychiatry & Behavioral Sciences)

The Role of the Circadian System in Oligodendrocyte Lineage Cells in Development and Disease

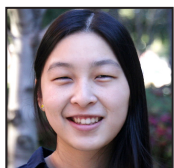


Chemotherapy often results in a host of neurological deficits, including cognitive and mental health disruptions, colloquially referred to as “chemobrain”. Jacob will determine the role of the circadian system in the regulation of glial cells, which surround the neurons to support and insulate them, in the etiology of chemobrain. The characterization of this system could yield neuroprotective strategies aimed at minimizing the effects of chemobrain, and could have implications for other mental health disorders.

Cynthia Hao, Bioengineering

Mentor: Roger Kornberg (Structural Biology)

A High-Throughput Pooled Screen for Cell Shape and Motility in Mammalian Cells



Cynthia will be analyzing 100 gene knockdowns in a bone cancer cell line for their effects on cell shape and motility phenotypes. Cynthia will employ a high-throughput pooled CRISPR screen that uses the *in situ* genetic barcode amplification and sequencing methods that she developed in previous Stanford Bio-X summer research and is continuing to optimize. By combining computational imaging analysis and a beta artificial neural network, Cynthia’s research will expand our understanding of the genetic mechanisms of cell shape and motility.





Edward Tran, 2020 cohort, has completed his Stanford Bio-X summer research training with Dr. Calvin Kuo

Ilham Osman, Human Biology

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

Using Virus-Inclusive Single Cell RNA-seq to Better Understand the Pathogenesis of Severe Dengue in Children

Dengue virus is a global pediatric health threat, with 5-20% of patients progressing to severe infection associated with morbidity and mortality. Ilham will learn how to analyze single cell transcriptomic datasets obtained from pediatric peripheral blood mononuclear cell samples with both uncomplicated and severe dengue. She will learn how to define cells that are infected with dengue virus in these samples and how to monitor the host response to dengue infections in multiple distinct cell subtypes in these samples.



Ethan Schonfeld, Biology

Mentor: Thomas Südhof (Molecular & Cellular Physiology)

Pathways to Transactivational Ability of the Amyloid-Precursor-Protein Intracellular Domain

Amyloid-beta precursor protein (APP) undergoes cleavage to release the extracellular A β product that is a hallmark of Alzheimer's disease. This cleavage also results in the production and intracellular retention of a fragment of the APP (termed the AICD) that has been demonstrated to form complexes which have transactivational activity. As there are some reports suggesting the potential but not-yet conclusive role of AICD in the development of Alzheimer's, Ethan's work seeks to expand on the trafficking, localization, complex identity, and target genes of the AICD.



Silver linings for our 2020 USRP cohort during COVID-19:

While all of our students miss Stanford campus life, they shared experiences they're grateful for which wouldn't have been possible during a "regular" on-campus quarter:



George Nakahara, 2020 cohort, has completed his Stanford Bio-X summer research training with Dr. Thomas Südhof

While training for a marathon, I am enjoying exploring the worlds of sourdough starter and raising ducklings!
—Ela Diffenbaugh

I've been grateful for my weekly Zoom meetings with my high school friends every Saturday night. We play online games for hours, like a group of old ladies meeting for Bingo. I look forward to my time with my friends because I can just be myself and laugh with them.
—Alanna Dorsey

I have been baking up a storm with my little sister. I'm so grateful to be able to spend quality time with her before she goes off to college next year. We have gotten so much closer since being stuck at home together.
—Keely Fuller

I've been especially grateful for the opportunity to take Zoom dance classes from instructors from all over the country—instructors who otherwise, I would not have met.
—Nicholas Gessner

One thing I'm grateful for is being able to spend more time with my baby brother and watch different cartoons with him!
—Mohammad Gumma

Among the other things I get to do while living on a horse farm, something that I am excited about will be my massive vegetable and fruit garden. I'm especially excited to harvest everything, cook and bake a lot more, and learn how to can produce!
—Alexis Ivec

One thing I've been grateful for is getting the opportunity to spend more time with family, such as learning how to make fresh pasta with my sister or playing video games with my brother.
—Christine Liu

Recently, I've been very grateful for skateboarding. I first learned how to ride a skateboard around the age of 6, and have been a casual rider since. I began skateboarding again at the beginning of this year, and I've been using it as a way to destress these past few months. I'm learning new tricks every week, and having tons of fun skating around in my apartment's parking lot.
—Darwin Luna

I've been participating in a book club with a couple friends this quarter, something we've been meaning to start for ages. We recently finished David Foster Wallace's *Infinite Jest*, which was super fun to read.
—Mohammed Osman

I'm grateful that I'm getting to spend more time with my grandparents than before.
—Sergey Pavlov

I'm grateful for the time to reconnect with old friends and to find my true calling as a harmonica/piano virtuoso.
—Calvin Taylor

I'm grateful for the time I've had with my family – being at home has helped me reflect on all that I've been given and the many ways to give back.
—Helena Zhang

Stanford Bio-X Undergraduate Summer Research Program



2014 Stanford Bio-X Undergraduate Summer Research Program Participants

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