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 occasion. 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 vibrant, 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 5 student mentors and their respective laboratories have adjusted the students’ projects so that they can be conducted long-distance to provide the students with rigorous research training.

Bio-X has sustained the hallmarks of our summer program in a virtual format so that students can participate live from home. Numerous workshops throughout the spring and summer quarters explore a variety of research-related skills, including analyzing manuscripts, formulating scientific questions, designing experiments, preparing posters, and more. Our weekly faculty talks expose students to the broad range of scientific fields and research that takes place at Stanford. The program will culminate with students designing posters detailing the progress of their summer work, giving them the opportunity to refine their skills at both visual and verbal research presentation.

Stanford Bio-X has also created a variety of additional programming to support and enhance this cohort’s experience. Recognizing that data science, bioinformatics, and computational work have only become more valuable in a time of social distancing,
we have developed a programming and statistics bootcamp to give our students an academic and professional edge. A wet lab learning series teaches specific wet-lab techniques through weekly group discussions led by experienced researchers so that students are prepared once they can work in labs again. A series of journal clubs facilitates critical thinking among the students as they collaborate in small groups and lead discussions about journal articles. Similarly, peer share meetings will encourage 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.

Bio-X remains committed to fostering a strong interdisciplinary training for these up-and-coming scientists, and we are excited to use our new and adapted curriculum to ensure that each of our undergrads will have 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 Pinker-Smith, Stanford Bio-X, and Anonymous Donors.
June 24  
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  
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 Sebastiani (Obstetrics & Gynecology), “Dissecting the role of TBX1 in 22q11 deletion syndrome”
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

“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:

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 Bodesign 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 and Student Resources:

In 2020, Stanford Bio-X is hosting 7 workshops for the Undergraduate Summer Research Program cohort designed to help the students grow as researchers, discover new tools, and identify skills and techniques to help maximize their summer learning.

The workshops, led by a team of Stanford Bio-X graduate students and postdocs (pictured below), are scheduled throughout the spring and summer to guide and prepare the students before and during their summer research experience. The session leaders are also a valuable resource for advice and mentorship for the cohort, both in terms of the topics covered and the students’ future careers.

Strategies for Reading, Analyzing, and Organizing Scientific Literature
April 2020
This workshop discussed 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
May 2020
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
May 2020
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, in this workshop, we talked about 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 are also encouraged to send their poster drafts to Alec and Chunzi for feedback and further discussion.

Setting and Achieving Goals
May 2020
A key question for the cohort is: 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
July 2020
In this workshop, students will learn how to visually represent the data they collect during their research. Annina will start with general guidelines about presenting data and managing space, design different ways to represent a dataset to achieve a specific goal, and discuss the design of Powerpoint Slides to support verbal presentations and guide viewer focus.

Oral Presentations
July 2020
A key aspect of doing a research project is communicating your work to others. In this workshop, Annina and Caitlin will talk about presenting a research project verbally, both in the context of giving a group meeting-style presentation and talking at a poster session, and help students to develop an 'elevator pitch' summary of their work.

Abstract & Proposal Writing
August 2020
In this workshop, Anna will discuss how to write clear, concise abstracts and research proposals. By the end of the session, students will have an understanding of what makes a successful abstract/proposal, as well as a template/set of guidelines for writing about their own research ideas.
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 age-associated neurodegenerative diseases, and many lysosomal storage disorders are indicated by neurodegeneration found in these age-associated neurodegenerative diseases. The shared pathophysiology 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)*  
**Mechanisms of Reduced Mutant Huntingtin Aggregation by a Small Molecule P75 Neurotrophin Receptor in a Mouse Model of 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.
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 avobenzone 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, undeclared  
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)  
Supporting Cell Heterogeneity within the Avian 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.
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.

Sid Suri Dhawan, Bioengineering  
*Mentor: Thomas Südhof (Molecular & Cellular Physiology)*  
**Designing CRISPR-Mediated Homology-Directed Repair (HDR) Templates to Elucidate the Role of Synaptic Transmembrane Proteins**  
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.

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)  
Analysis of Circulating Tumor DNA in Lung Cancer Patients to Predict Patient Outcomes  
Tumors release DNA into the bloodstream in response to therapy, which can be identified from routine blood draws as circulating tumor DNA. Sophia will combine molecular biology, cancer biology, bioinformatics, and clinical research to determine if changes in circulating tumor DNA during therapy can help to elucidate the biology of lung cancer treatment response and to 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  
Immune cells are key mediators in bone regeneration but remain understudied. Peyton will harness the capabilities of micro-ribbon scaffolds and address a possible hypothesis regarding immunomodulation for bone regeneration. Peyton’s research takes place at the interface of biomaterials, immunology, stem cells, and tissue engineering, and will have broad impacts on designing 3D macroporous 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.
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.

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.

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, will complete her Stanford Bio-X summer research training with Dr. Karl Deisseroth
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.

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.

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.
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.

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

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.

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.
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.
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.

Darwin Luna, undeclared  
*Mentor: Jun Ding (Neurosurgery and Neurology & Neurological Sciences)*  
**Understanding the Role of Learning in Alcohol Use Disorder**  
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.

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 deferentially valued environmental stimuli, to characterize how value is represented in genetically defined cell types in the orbitofrontal cortex.
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.

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.

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.
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.
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 microorganisms 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)

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.
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.

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.

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.

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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)
Evolution and Replication of RNAs by DNA-Dependent RNA Polymerases from Across the Tree of Life
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*), 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.

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.

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.

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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.
**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 Aβ 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.

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**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.

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**Edward Tran, 2020 cohort, will complete his Stanford Bio-X summer research training with Dr. Calvin Kuo**
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:

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
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