Keck Graduate Institute

Summer Undergraduate Research Experiences (SURE) Program

June 14 – July 23, 2027

Independent Research Projects

We are offering research opportunities in

A: Biology (wet lab research)

B: Computational Biology (mainly data analytics, but some projects also have a wet lab component)

C: Engineering (medical devices and bioprocessing)

D: Business / Social Sciences

For your application, please select the top three projects you are interested in, and in your essay discuss why you are interested in these projects, and what skills (lab, computational, etc.) you possess that would make you a good candidate.

A: Biology:

Project Number: A1

Project Title: Targeting GPCRs in Th17 Cells for Autoimmune Disease Treatment and Cancer Immunotherapy

Advisor: Jeniffer Hernandez

Description:

Our laboratory investigates how G protein–coupled receptors (GPCRs) regulate Th17 cell function and metabolism in autoimmune disease and cancer. We aim to determine whether targeting these receptors can reduce inflammation in multiple sclerosis or enhance immune responses against tumors.

Students will characterize candidate GPCRs using Western blotting, quantitative PCR, flow cytometry, metabolic assays, and cell culture. Small molecules will be used to activate or inhibit selected receptors and assess their effects on T-cell activity and cytokine production. Depending on project assignment, students may participate in studies using experimental autoimmune encephalomyelitis (EAE), a mouse model of multiple sclerosis, or examine interactions between T cells and tumor cells or tumor organoids to explore potential cancer immunotherapies.

Students with a background or interest in molecular and cell biology, immunology, or cancer biology would be well suited to this project.

Project Number: A2

Project Title: Drug discovery and signaling in Alzheimer's Disease, Epilepsy focused on Excitation Inhibition Balance in the brain

Advisor: Subhrajit Bhattaxcharya

Description:

The Bhattacharya laboratory is interested in neuroscience research in general believing that only a fraction of the “brain story” has been read so far. A range of scientific discoveries are needed to get a better understanding of complex neural networks specifically in the field of synaptic plasticity and how it is affected in diseases like epilepsy, Alzheimer's Disease (AD) and others. My training in neuroscience and pharmacology allows me to investigate in-depth mechanisms of drug action in the CNS using cellular and animal models. Supported by my postdoctoral training in molecular neuroscience and electrophysiology (Emory University Medical School with Drs. Stephen Traynelis and Raymond Dingledine), this interest grew into a long-term goal to study how receptors play a major role in different diseases. Current research goals of our lab include 1) synaptic mechanisms of glutamate receptor subtype mediated activities and 2) intense electrophysiology aided drug development of NMDAR subtype-selective compounds in epilepsy and AD. We have recently developed novel biased modulator compounds for the NMDA receptors that will be tested for dementia and other disease states. 3) We are also interested in understanding AMPAR and its novel auxiliary units, signaling in different parts of the thalamus in Parkinsonian models, stroke and channelopathies.

Students interested in wet lab research involving cell culture, animal tissue and having background in neuroscience and molecular biology, animal work, tissue dissection, will have opportunities to participate in the above-mentioned research projects.

Project Number: A3

Project Title: Alzheimer's disease drug discover

Advisor: Derick Han

Description:

The goal of the project is to explore and test drugs in cell culture that may modulate proteins that regulate amyloid-beta for potential therapy in Alzheimer's disease.

Project Number: A4

Project Title: Analyzing the role of transcription accessory factors in the development of colorectal cancer

Advisor: Barbara Fortini

Description:

Projects will use human cell culture and organoids to study the genetic risk factors for colorectal cancer.

Project Number: A5

Project Title: Designing Therapies for Neurological Disorders

Advisor: Barbara Bailus

Description:

The Bailus Lab focuses on neurological disorders, with a specific emphasis on gene therapy and delivery mechanisms. We build custom proteins in the lab that have the ability to cross the blood brain barrier and have a therapeutic effect. Some of the diseases and disorders studied in the lab include Angelman syndrome, SETBP1 Haploinsufficiency Disorder, Huntington's disease and Alzheimer's disease. Students in the lab will have the opportunity to learn a variety of techniques that may include human and mouse cell culture, cloning, western blots, protein purification, and immunostaining. The lab is open to potentially having students continue past the summer as part of their senior thesis.

B: Computational Biology

Project Number: B1

Project Title: Biochemical Characterization of Ancestrally Reconstructed Enzymes

Advisor: Cesar Espinoza

Description:

Many bacteria have a polysaccharide capsule that a phage must penetrate to infect its host. We have recently isolated and sequenced the genomes of several phages and identified potential depolymerases. Using AI/ML approaches, we reconstructed the ancestral states of these proteins and evaluated their potential depolymerase activity. The student will perform biochemical experiments to characterize these enzymes and link their activity to the realized host range of the phages.

Arbovirus Vector Species Distribution Modeling Using Neural Networks

Arbovirus vectors pose a significant public health burden in tropical regions, and their geographic distributions are expected to expand under current climate change scenarios. The student will develop species distribution models using convolutional neural networks to predict the distributions of known and potential arbovirus vectors. These models will then be evaluated under different global change scenarios to identify potential areas of future introduction and expansion.

Project Number: B2

Project Title: Biophysical Mechanisms of Protein Evolution

Advisor: Animesh Ray

Description:

How do individual amino acid changes interact to shape the evolutionary trajectory of a protein? While single mutations alter protein structure and function, combinations often produce non-additive effects—a phenomenon known as epistasis. Our research explores how proteins navigate these complex fitness landscapes. We build physics-augmented computational models of epistatic interactions and validate them against experimental wet-bench data. Summer researchers in our lab integrate computational modeling with experimental assays to help decode evolutionary mechanisms and design functional, novel proteins not found in nature.

Project Number: B3

Project Title: Improvement of proteins by computational design, expression in the yeast Pichia pastoris and analysis of properties of the purified novel proteins.

Advisor: Ilya Tolstorukov

Description:

We utilize computational tools developed by this year's Nobel Prize laureates in chemistry to analyze and optimize the structures and properties of anti-SARS-CoV-2 antibodies, as well as enzymes perspective for medical and technical applications. The designed protein sequences are used to synthesize corresponding genes, which are then cloned into yeast vectors to create yeast strains that express these proteins. Using advanced bioprocessing technology, we produce and purify these novel proteins, followed by detailed analysis of their properties, such as antibody-antigen interactions or the catalytic activity of enzymes.

We invite students with a background in computational biology or bioinformatics, or those with basic laboratory skills in microbiology, molecular biology, or biochemistry.

C: Engineering

Project Number: C1

Project Title: Left ventricle assist device development

Advisor: Anna Hickerson

Description:

Left side heart failure occurs when the left ventricle is unable to pump enough blood to sustain necessary flow for life. In advanced stages, a patient may receive a left ventricle assist device implant. These devices have many shortcomings and have limited results. Students with a background in bioengineering, mechanical engineering, or electrical engineering will have the opportunity to participate in the development and testing of a new design concept intended to overcome several of those challenges.

Project Number: C2

Project Title: Integration of RT-MALS for Real-Time Monitoring of AAV Quality Attributes During Purification

Advisor: Shiva Abdolrahimi

Description:

This project aims to integrate real-time multi-angle light scattering (RT-MALS) into adeno-associated virus (AAV) purification to strengthen process understanding and support process analytical technology (PAT)-enabled manufacturing. RT-MALS will be evaluated during ion-exchange chromatography to monitor AAV attributes, including capsid and viral genome concentrations, genome content, the relative abundance of empty and full capsids, and aggregation, using light-scattering measurements combined with complementary detector signals and appropriate analytical models. These measurements will be integrated with process data and orthogonal analyses to assess their ability to inform fraction collection, pooling decisions, and purification optimization. The long-term goal is to establish a monitoring strategy that supports consistent product quality, improved recovery, and scalable AAV manufacturing.

D: Business / Social Sciences

Project Number: D1

Project Title: Using AI Tools to Study Regional Biotechnology Clusters

Advisor: Steve Casper

Description:

Spurred by the success of Silicon Valley and other regional technology hubs, governments have created policies to develop biotechnology clusters. This project aims to compare the emergence and sustainability of biotechnology clusters developed in conjunction with major investments in public research institutes in Singapore and San Francisco. Beginning in the early 2000s the Singaporean government invested several billion dollars to create Biopolis, a campus in which several public biomedical research institutes are co-located within research laboratories of many pharmaceutical companies. San Francisco's biotech cluster expanded rapidly with the opening of UCSF's Mission Bay Campus in 2003, a facility that became a magnet for investments by several pharmaceutical companies and a hot bed for biotech start-ups. Drawing on large data lakes of bibliometric and patent data, the project will use AI tools to mine information to help better understand the composition of university-industry linkages in the two regions and, through doing so, help better understand policy approaches towards the development of technology clusters.

Project Number: D2

Project Title: Venture Funding and Innovation in Rare Diseases

Advisor: Yun Liu

Description:

Developing treatments for rare diseases involves substantial scientific uncertainty, long development timelines, and small potential markets, creating distinctive financing challenges. Students will investigate how different investors—including traditional venture capital firms, corporate venture funds, and venture-philanthropy organizations—support rare-disease startups and influence their development pathways. Using publicly available information, students will identify relevant investors and companies, compile key characteristics, and compare selected cases. The analysis may examine investment patterns, therapeutic areas, stages of development, partnerships, acquisitions, initial public offerings, or other outcomes, depending on the available evidence. Students interested in biotechnology, finance, entrepreneurship, economics, or healthcare will have the opportunity to learn about an emerging area of life-sciences investment while developing skills in data collection, analysis, and research communication.