Hybrid Archaeosomes with Extraordinary Stability and Controlled Release Capability

This research aims to design, construct, and test a new thermosensitive liposome drug delivery system that can overcome the issues of stability, controlled release, and target specificity altogether in the same single formulation and achieve a much higher anticancer efficacy compared to conventional thermosensitive liposomes. Specifically, we plan to develop hybrid archaeosomal drug containing archaeal tetraether lipids and diester lipids, which will be extraordinarily stable and inactive at the body temperature and can be turned to actively deliver drug molecules and kill cancer cells in the tumor areas that are subject to local hyperthermia treatment (i.e., from 37 to 42-44°C). The ultimate goal is to develop this smart material-based liposome formulation into a new clinical approach that will significantly increase the overall anticancer therapeutic efficacy and reduce the side effects of chemotherapy. Through this project, students can learn how to grow thermoacidophilic archaia, isolate tetraether lipids from archaea cells, make archaeosomes and archaeosomal drugs, characterize physical properties of archaeosomal drugs and their interactions with serum proteins and mammalian cells.

Location: HSC: In-person essential
Student Majors Desired: Chemistry, Biology, Biophysics
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: general chemistry

Parkson Chong
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LKSOM
Medical Genetics & Molecular Biochemistry
Epigenetics in fibrosis

Approximately six million adults in the US suffering from heart failure (HF), representing a significant health care burden for the nation. A common feature of HF is excessive extracellular matrix deposition by a specialized and differentiated fibroblast population, known as myofibroblasts, in response to injury of the heart. While myofibroblasts help maintain the structure of the injured heart and prevent heart wall rupture, persistence of myofibroblasts results in excessive fibrosis and cardiac dysfunction. Therefore, identifying molecular mechanisms of myofibroblast differentiation in cardiac fibrosis could yield novel clinical targets to delay or reverse the development of HF. Our lab is studying the mechanisms by which metabolism controls the epigenetic reprogramming of myofibroblasts. We hypothesize that stress and injury alter the metabolism of cardiac fibroblasts and affect how small molecule metabolites mediate changes in epigenetics and chromatin structure to activate the myofibroblast gene program.

Location: HSC: In-person essential
Student Majors Desired: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: N/A
Calcium regulation of mitochondrial function

The powerful second-messenger, calcium, regulates numerous cellular functions by binding distinct calcium sensing domains or motifs present on numerous proteins. Calcium concentration varies greatly between different cellular compartments, and thus sensors of calcium are strategically localized for subcellular/organelle-specific signaling. Mitochondria actively regulate their calcium concentration and contain calcium sensors to mediate anterograde and retrograde signaling. Mitochondrial Calcium Uptake proteins (MICUs) in the mitochondria contain calcium-binding EF-hand domains, resulting in the regulation of mitochondrial calcium flux, ionic homeostasis, bioenergetics, and cell death. Post-translational modifications and protein turnover are the critical determinants of MICU1 function. We are identifying new regulators associated with mitochondrial calcium flux and their role in pathophysiology using discovery-based approaches, protein biochemistry, high-end imaging-based approaches, and genetic manipulation. We will characterize the pathophysiological consequences of these signaling events in mutant mouse models of disease.

Location: HSC: In-person essential
Student Majors Desired: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: N/A
Mitochondrial calcium exchange plays a critical role in regulating cellular bioenergetics, but also contributes to cell death. The overall goal of this project is to understand how alterations in mitochondrial calcium exchange contribute to cardiac injury and heart failure. Our lab has generated numerous genetic mouse models to knock out or overexpress the genes facilitating mitochondrial calcium uptake and efflux in the heart, and we are currently using surgical models of heart failure to assess how perturbation of these pathways protects or predisposes to heart disease. We are also taking in vivo and in vitro approaches to understand the molecular mechanisms that regulate the activity of these calcium handling proteins in order to understand how they could be targeted therapeutically. Students will gain experience in standard cell and molecular biology techniques as well as mouse handling, genotyping, and cardiovascular phenotyping. We seek driven, dependable individuals for this project.

**Location:** HSC: In-person essential  
**Student Majors Desired:** All Majors  
**Class Preferences:** Freshmen, Sophomores, Juniors & Seniors  
**Important Selection Criteria:** N/A
Mitochondrial function in Alzheimer’s disease

Currently, ~5.8 million Americans suffer from Alzheimer’s disease (AD) and there remain no approved therapeutics to lessen the associated neuronal dysfunction and cell death. Various AD clinical trials targeting the “amyloid cascade” have proven unsuccessful, suggesting a dire need to rethink AD disease progression. Alterations in cellular calcium and mitochondrial function are reported as critical molecular contributors to AD pathogenesis. Our lab has previously shown that genetic modulation of either mitochondrial calcium uptake or efflux is a powerful way to limit mitochondrial dysfunction and cell death in the context of cell stress. As causal evidence of impaired mitochondrial calcium exchange in AD, we generated multiple mutant mouse models to modulate mitochondrial calcium exchange and discovered that impaired mitochondrial calcium efflux proceeds neuropathology and memory decline in AD mutant mouse models. In this project, we hypothesize that mitochondrial calcium overload is a primary contributor to AD pathology by promoting metabolic dysfunction and neuronal cell death, and that reducing mito-calcium uptake will impede neurodegeneration and AD pathogenesis. Optimally, these studies will identify new therapeutic targets for the treatment of AD.

Location: HSC: In-person essential
Student Majors Desired: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: N/A
Novel genes regulating heart failure

The advent of genomic sequencing revolutionized the field of science, allowing for the annotation of the entire human genome. This sequencing led to the discovery that ~90% of the human genome is transcribed from DNA to RNA, but only ~1% has been identified as being translated into protein. While there are many possible functions of the untranslated RNA, some of these transcripts have the potential to be unidentified protein-coding genes. One reason for this discrepancy in annotations, is that small transcripts are typically excluded from both biological and bioinformatic peptide discovery applications, due to the high rate of misidentification. Recent studies, have identified the translation and biological functions of numerous small transcripts, highlighting the need for re-analysis of this subset of the genome. To discover novel genes involved in the development of heart failure, our group has created a bioinformatic pipeline to identify differentially expressed transcripts with protein coding potential. To date we have predicted coding potential for 26 novel genes and are in the process of confirming translation before determining function.

Location: HSC: In-person essential
Student Majors Desired: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: N/A
Novel cell death pathways – focus on necrosis

Necrosis is an umbrella term for the pathological form of inflammatory cell death, common to many chronic diseases. The collective characteristics of necrotic sub-pathways include membrane rupture and the release of cell contents into the extracellular space leading to an immune response. Despite the convergence of these pathways on membrane rupture, the mechanisms underlying the commonalities in necrotic membrane rupture remain unknown. Using a high throughput lentiviral screen, we have identified the SNARE complex as a key regulator of membrane rupture after numerous necrotic stimuli. Our studies have found that knockout of N-ethylmaleimide sensitive factor (Nsf), the protein responsible for SNARE complex recycling, is protective against membrane rupture in the skeletal muscle, heart, and fibroblasts following varying necrotic stimuli. Our ongoing studies delve into the post-translational modifications of Nsf after cell death stimuli. We aim to understand if prevention of Nsf modifications post necrotic stimuli reduces membrane rupture and subsequent cell death. The identification and mechanistic understanding of genes driving cellular necrosis will pave the way for the development of new therapeutics for the treatment of chronic cell death driven diseases.

Location: HSC: In-person essential
Student Majors Desired: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: N/A
Mitochondria-SR Tethering in heart disease

In cardiomyocytes, the sarcoplasmic reticulum (SR) and mitochondria form close interfaces that are maintained by protein tethers which keep the organelles in close apposition. The close proximity between the SR and mitochondria facilitate calcium homeostasis and excitation-contraction coupling which are essential for proper cardiomyocyte function. Abnormalities in SR calcium cycling, transverse-tubule remodeling, and mitochondrial calcium overload are hallmarks of heart failure and contribute to the pathophysiology and progression of heart disease. This project examines the role of the SR protein, PDZD8, in SR-Mitochondria tethering. It employs multidisciplinary approaches ranging from molecular and cell biology, fluorescent, super resolution confocal microscopy and clinically relevant mouse models of heart failure to gain insight into the fundamental principles regarding the role of SR-mitochondria contact sites in cardiovascular diseases.

Location: HSC: In-person essential
Student Majors Desired: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: N/A

Genetics and Epigenetics of sex-specific expression patterns in early embryogenesis

We are investigating differences between male and female mouse embryonic stem cells and mouse embryos, and identifying the mechanisms by which these early differences are established. We integrate gene expression, DNA methylation and chromatin conformation analyses with bioinformatics to establish how sex biases affect cellular phenotypes in health and disease.

Location: HSC: In-person essential
Student Majors Desired: Biology
Class Preferences: Juniors & Seniors
Important Selection Criteria: Basic laboratory skills, such as pipetting, running gels, PCR and making solutions required.
Lung Cancer Screening Community and Provider Education

Project Leadership of Community Education and Coordinator for Provider Education as a Student Worker Lung Cancer Screening Researcher. We are one of the nation's largest screening programs. We have demonstrated success in engaging diverse and underserved populations. We are looking to grow this program by engaging health care providers, partnering institutions, community leaders, and people at high risk of lung cancer. Our work is supported by the American Cancer Society Pfizer grant to mitigate health care disparity in cancer care.

Responsibilities: Manage media campaigns, continuing medical education, Manage communication with partner hospitals and health systems; Coordinate with patients directly on Education, Navigation & Maintain confidentiality; Manage research portfolio: Manage IRB proposals and renewals, Manage communication with researchers and team, Help with preparation of manuscripts, publications and abstract submissions, manage data, surveys.

Location: HSC: Virtual to start, but could shift to in-person if the University approves

Student Majors Desired: All majors, but career goals related to healthcare or health policy

Class Preferences: Freshmen, Sophomores, Juniors & Seniors

Important Selection Criteria: Qualifications: 1. One year community outreach and/or health education experience preferred. 2. Ability to build trust quickly with community members and agency partners. 3. Excellent customer service skills, interpersonal skills. 4. Ability to work as pa
Cancer Bioengineering and Cancer Microscopy

Student would use multiphoton and confocal fluorescent microscopes to image cancer cells labeled with 3 different fluorescent proteins. The goal is to compare how motility of cells relates to cell cycle stage distribution in 3D cellular spheroids embedded in collagen matrix. We hypothesize that cells which are motile will be arrested in G1 stage and that spatially, such cells will be positioned in the rim of the spheroid. The results have an application in the field of cancer drug resistance, which is the main cause of remission today.

Location: Main: In-person essential
Student Majors Desired: Biochemistry, Biophysics, Natural Sciences, Pre-Health
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Use of microscopes, sterile cell culture, cell transfection and transduction, PCR, microarrays, immunofluorescence or histology.
Regulation of the PP2A tumor suppressor in normal and cancer cells

There are various projects available that deal with the characterization of the substrate specificity of the B55α/PP2A holoenzyme, its regulation in normal cells and its deregulation in cancer. (1) B55α/PP2A holoenzyme substrate specificity. This project focuses on determining the determinants of substrate specificity of B55α/PP2A holoenzymes using various unrelated substrates of this holoenzyme. We have an extensive collection of B55α and substrate mutants and more to be made to be tested for binding using transient co-transfections made in human cells grown in culture. The project involves cell culture, transfections, immunoprecipitation, western blot analysis and generation and maintenance of plasmids. (2) To identify the motifs in substrates recognized by B55/PP2A protein phosphatases. This project is centered on determining the amino acid residues that mediate the interaction of various substrates with the PP2A. We have an extensive collection of GST-mutants to characterize these interactions. More mutants will be generated based on bioinformatics docking analysis and the results of binding assays. The project involves cell culture, GST pull-down assays, western blot analysis and generation and maintenance of plasmids. (3) Role of B55alpha/PP2A holoenzymes in prostate cancer. The project involves cell culture, organoid growth, transfections, immunoprecipitations, western blot analysis and generation and maintenance of plasmids. It may also involve confocal microscopy. (4) Immortalization of primary prostate cells and establishment of primary cancer cells. The project involves cell culture, organoid growth, transfections, immunoprecipitations, western blot analysis and generation and maintenance of plasmids. It may also involve confocal microscopy. (5) Role of B55alpha/PP2A holoenzymes in prostate cancer. The project involves cell culture, organoid growth, transfections, immunoprecipitations, western blot analysis and generation and maintenance of plasmids. It may also involve confocal microscopy.

Location: HSC: In-person essential
Student Majors Desired: Biochemistry, Biology, Bioinformatics - Genetics and/or Biochemistry and/or Cell Biology
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Motivation for Science and Research. Background knowledge: Previous lab experience is NOT required
Role of Methamphetamine and/or HIV in Brain Damage

METH, a potent addictive psychostimulant, is one of the most abused drugs in the United States. METH abuse is highly prevalent in HIV-infected individuals, which presents unique challenges for HIV prevention and treatment. Given the overlap impact of METH use and HIV on neuronal damage in the CNS, it becomes urgent to understand the role of interplays between METH and HIV in the pathogenesis of HIV associated neurocognitive disorders (HAND). The goal of this project is to address the hypothesis that METH use and/or HIV infection inhibit host innate immunity and facilitate inflammation. There are two specific aims: 1. To examine whether METH and/or HIV inhibit the intracellular viral restriction factors in newly established brain cell model (iPSC-derived microglia and neurons). 2. To determine whether METH and/or HIV infection induce expression of the inflammasomes/neurotoxic factors and promote the death of neurons.

Clinical significance of this project. To understand how two major pathologic factors (HIV and METH) compromise the brain immunity and facilitate neuronal death should improve and advance our knowledge for developing therapies to prevent or eradicate HIV infection and persistence in the brain.

Students will: 1. Learn techniques such as RT-PCR, cell culture, western blot, flow cytometry assay, and data analysis; 2. Do a small and feasible research project: to examine if stem cell-derived microglia and neuronal cell produce interferons (IFNs) and IFN-stimulated genes. 3. understand importance of paying a great attention to details.

Location: HSC: In-person essential
Student Majors Desired: Molecular Biology, Genetics, Biology, Neuroscience
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: High motivation for science, responsible and reliable, hardworking
Molecular mechanisms of hypothalamic neurogenesis and neural metabolic syndrome

The research interest in Dr. Hu’s lab focuses on the role and mechanisms of a novel protein NIBP, which regulates NFkB signaling and trans-Golgi networking. Mutation of NIBP contributes to mental retardation, autism, obesity and stroke. In particular, NIBP knockout mice develop obesity under normal diet. Also, the lab is interested in the novel role of the schizophrenia and autism spectrum disorder gene TCF4 in regulating neuritogenesis and synaptic plasticity. The qualified students will actively participate in the daily research activities in the laboratory. These activities include: neural stem cell culture, transfection, reporter gene assay, CRISPR/Cas9 genome editing, molecular cloning, RT-PCR, Western blot, immunohistochemistry, confocal imaging, genotyping, phenotyping and data mining. The students will also participate in the weekly journal club and weekly seminar in the center/department. The students are expected to understand the research publications by Dr. Hu’s group as well as the current progresses in the field of neural metabolic diseases, adult neurogenesis and genome editing. The students with previous research background will be given a small research project that potentially generates publishable data.

Location: HSC: In-person essential
Student Majors Desired: Neuroscience, Biology, Psychiatry, Bioengineering, Computer science
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Motivation for science, responsible and reliable
Target-specific delivery of CRISPR/Cas9 genome editors to Disease-relevant cells

CRISPR/Cas9 genome editing has been drawing extensive attention in both science and public. It has revitalized the gene and cell therapy. A large number of exciting and promising preclinical studies escalate the potential of genome editors to treat patients with genetic diseases, infectious diseases, cancer and others. One of many challenges before wide clinical application is the urgent need to effectively, specifically and safely deliver the powerful genome editing machinery to disease-relevant cells and tissues. Dr. Hu’s lab is interested in developing novel viral and non-viral gene delivery for Cas9/sgRNA-expressing vectors or ribonucleoprotein by targeting neural, immune and cancer cells. The qualified students will actively participate in the daily research activities in the laboratory. These activities include: Data mining, molecular cloning, PCR genotyping, real-time PCR, genome editing evaluation, cell culture, transfection, reporter gene assay, Western blot, immunohistochemistry, confocal imaging, etc. The students are expected to understand the research publications by Dr. Hu’s group as well as the current progresses in the field of genome editing and gene/cell therapy. The students with previous research background will be given a small research project that potentially generates publishable data.

Location: HSC: In-person essential
Student Majors Desired: Molecular Biology, Genetics, Biology, Neuroscience
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: High motivation for science, responsible and reliable, hard-working
Development of drug delivery systems with enhanced in vivo stability

Drug delivery systems can modify the pharmacokinetics of drugs, protect them from decomposition and control their spatial and temporal delivery in the organism. In recent years we were involved in the development of drug delivery systems based on amphiphilic compounds of different molecular weight, from simple surfactants, gemini surfactants, lipids, dendrons and polymers. We are currently seeking talented and highly motivated students to develop the next generation of drug delivery systems with enhanced in vivo stability capable of long circulation time in the human body. Students majoring in chemistry, biochemistry and biology are welcomed. Experience in working with cells and animal models is a plus but it is not required.

Location: HSC: In-person essential  
Student Majors Desired: Chemistry, Biochemistry, Biology  
Class Preferences: Freshmen, Sophomores, Juniors & Seniors  
Important Selection Criteria: General knowledge in chemistry, biochemistry, biology and especially in the interdisciplinary integration of this knowledge is needed.
Synthesis, physicochemical and biological evaluation of novel carbonic anhydrase inhibitors, activators and their pharmaceutical formulations

Carbonic anhydrases (CAs, E. C. 4.2.1.1) are a class of ubiquitous metalloenzymes that catalyze the reversible hydration of carbon dioxide: CO₂ + H₂O ↔ HCO₃⁻ + H⁺. Fourteen isoforms are currently known in humans, with different catalytic activity, subcellular localization and tissue distribution. These isoforms are involved in critical physiologic and pathologic processes including respiration, acid-base regulation, electrolyte secretion, bone resorption/calcification, gluconeogenesis, tumorigenicity and the growth and virulence of various pathogens. Some of them are over-expressed in pathological conditions such as edemas, glaucoma, obesity and cancer. Therefore CA isoforms have become important targets for pharmaceutical research. We are seeking talented and passionate individuals to be involved in the synthesis, physicochemical and biological testing of novel selective CA inhibitors and of their pharmaceutical formulations aiming towards treatment of various forms of cancer via novel drugs and drug delivery systems.

Location: HSC: In-person essential
Student Majors Desired: Chemistry, Biochemistry, Biology
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Previous experience in synthesis, physicochemical and/or biological evaluation of organic compounds and their formulations, as well as towards tissue cell cultures constitutes a plus.
**Human cardiac progenitor cell exosomes for cardiac regeneration**

Injury to the heart leads to development of a scar that never goes away. Current therapies do not target regeneration of the heart of scar replacement. Our current research utilizes cardiac progenitor cells isolated from human heart samples. Tiny vesicles called exosomes from human cardiac progenitor cells that carry immense therapeutic potential will be tested for their ability to repair the heart after myocardial injury.

**Location:** HSC: Virtual to start, but could shift to in-person if the University approves  
**Student Majors Desired:** Biology, Biochemistry  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** N/A

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**Neutrophil-endothelial interactions in Sepsis**

Sepsis is a major health care problem in the US with more than 1.5 million cases/year and greater than 200,000 deaths/year. This disease is characterized by an intense systemic inflammatory response which activates a cascade of proinflammatory events resulting in tissue damage and organ failure. To date, therapeutic approaches to the treatment of sepsis are largely supportive and there are no specific pharmacologic therapies available. In a translational research project, we are testing the therapeutic effects of a specific kinase inhibitor in a rodent model of sepsis and in an in vitro "tissue on a chip" model. In this project, we will evaluate the effect of this inhibitor on sepsis-induced immune cell migration, programmed cell death (apoptosis), and pathogen clearance. Cell isolation techniques and culture of primary cells and cell lines will be employed. Western blotting, spectrophotometric, fluorometric and flow cytometry techniques will be used to determine therapeutic efficacy.

**Location:** HSC: In-person essential  
**Student Majors Desired:** Biochemistry, Chemistry, Biology  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Some previous lab experience, highly motivated with an interest in research

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Center for Metabolic Disease Research

Laurie Kilpatrick  
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Department of Thoracic Medicine and Surgery/ CILR
The role of cell signaling and polarity in neural development

My laboratory's research focuses is to understand the molecular and cellular mechanisms controlling brain development to study the basis of neurodevelopmental disorders. To gain in-depth knowledge of neural development and neuronal disorders, we utilize multidisciplinary approaches such as molecular and neuroanatomical techniques including gene cloning, progenitor or neuronal culture, cortical electroporation and time-lapse imaging of cortical explants. Students will involve the characterization of animal models exhibiting abnormal cortical or cerebellar development and gene cloning projects to clone the genes that are critical for regulation of proliferation and differentiation during neurogenesis.

Location: HSC: In-person essential
Student Majors Desired: Biology
Class Preferences: Juniors & Seniors
Important Selection Criteria:

Innate immune functions of airway epithelium

Genotyping and biochemical and behavior characterization of mutant mouse lines, including phosphorylation-deficient KOR mutant mice, b-arr2 knockout mice and KOR-tdTomato mice. Screening for selective KOR agonists that produce analgesic and anti-itch effects, but do not cause side effects such as aversion, sedation and motor incoordination.

Location: HSC: In-person essential
Student Majors Desired: Neuroscience, Biochemistry
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Solid grades, eager to learn, organized, some lab experience preferred
Characterization of a knockin mouse line expressing a fusion protein of the kappa opioid receptor (KOPR) and the fluorescent protein tdTomato (tdT) [KOPr-tdT]

Lack of specific antibodies against the KOPR has hindered in vivo study of KOPR in terms of localization, trafficking, expression and signaling. My lab has generated a knockin mouse line expressing KOPR-tdT. The project is to do genotyping of the mice and map the distribution of KOPR-tdT in the brain.

Location: HSC: In-person essential
Student Majors Desired: Neuroscience
Class Preferences: Juniors & Seniors
Important Selection Criteria: Solid grades, eagerness to learn, organized, some lab experience preferred, experience in handling rodents, perfusion and tissue sectioning is a plus.

Risk and Protective Factors Associated with AD/ADRD and CRC Among the High-Risk Low-Income Asian American Elderly

In this study, we investigate the influence of multiple lifestyle factors on AD/ADRD and the underlying mechanisms through which they interplay to affect AD/ADRD health outcome. We are conducting an epidemiological study to collect cross-sectional data among 300 low-income Asian American elders and analyze the data using binary logistic regression and structural equation modeling.

Location: HSC: Virtual to start, but could shift to in-person if the University approves
Student Majors Desired: Neuroscience, psychology, biology
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Passion and commitment in health disparities research are required. Training and experience in cognitive health, behavioral health, and data analysis are a plus.
Unpacking Mechanisms of Disparities for HIV-related Hypertension in African Am and Asian Pacific Am MSM

The research team at Center for Asian Health (CAH), KLOM along with the team at the University of Hawaii at Manoa, is interested in determining the disparities for HIV-related Hypertension in African American and Asian Pacific American MSM. The purpose of this study is to learn more about how to better manage healthy living (e.g., without high blood pressure or hypertension) associated with the HIV disease. The finding of this study will help in creating effective prevention programs. Students will participate in recruiting eligible participants, conducting baseline and follow-up data collection, literature review, data management and presentation. Other research projects on a wide range of topics, including chronic illness, cancer screening, diagnosis, prevention, and treatment, behavioral intervention, and cognitive health are also available at CAH.

Location: HSC: Virtual to start, but could shift to in-person if the University approves
Student Majors Desired: Biology, Neuroscience, Psychology, etc.
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Passion and commitment in health disparities research is a requirement. Previous training and/or experience in public health, data analysis, community engagement constitutes a plus.
An injectable piezoelectric hydrogel for periodontal disease treatment

Periodontitis continues to be a global health problem: combined with edentulism and severe tooth loss, it constitutes the 6th most prevalent long-term disease worldwide affecting 10% of the global population, 65 millions of Americans, with an estimated cost of loss of productivity of 54 billion USD/year. Non-surgical approaches to treat periodontitis include scaling and root planning (SRP) with or without adjunct antibiotics. SRP with adjuvants have been used regularly for decades yet are still insufficient to solve the condition. Major limitations exist in the use of SRP with adjuvant antibiotic including limited regeneration of periodontal tissue, frequent re-applications of drugs, not applicable to larger size pockets. If non-surgical treatment is ineffective (continued inflammation, no significant pocket depth reduction), surgery may be indicated. In our lab, we developed a composite with piezoelectric fillers. Our preliminary results showed that piezoelectric charges elicit both antibacterial and tissue regeneration therapies. We are adapting this technology to develop a light curable injectable piezoelectric hydrogel (PiezoGELTM) for periodontal disease treatment with combined antibacterial and tissue regeneration effects. Through a minimally-invasive probe, the hydrogel solution could be injected into the periodontal pocket and light cured to form a graft in situ. Our main hypothesis is that this piezoelectric hydrogel is stimulated from jaw vibrations to generate useful surface charges to elicit both antibacterial and tissue regeneration effects for periodontitis treatment. The project will have two specific aims. Aim 1 is to optimize the formulation of PiezoGELTM for clinical delivery. Aim 2 is to demonstrate the improved periodontium regeneration capability of PiezoGELTM in vivo using a rabbit model compared to standards adjuvants. PiezoGELTM could serve as a powerful platform for the treatment and regeneration of different tissues including bone, dentin, skin, etc.

Location: HSC: In-person essential
Student Majors Desired: Bioengineering, Biology, Mechanical eng
Class Preferences: Juniors & Seniors
Important Selection Criteria: Our work is wet lab. Ideally, experience with cell cultures and pipette manipulation.
Therapeutic secrets of kratom alkaloid mitragynine: Testing efficacy in neuropathic pain and abuse liability models and characterization of underlying opioid and adrenergic mechanisms

More than 20 alkaloids, several of which are biologically active, have been isolated from the Mitragyna speciosa plant known as kratom, with MG being the major one, accounting for 66.2% of the crude base and 6% by weight of the dried plant. In Southeast Asia, kratom has been used for centuries as a stimulant to counteract fatigue and also as an herbal remedy for depression, pain, opioid withdrawal, fever, anxiety, and diarrhea. Kratom’s ‘opioid-like’ effects have gained the most public attention and are presumed to be primarily responsible for its ‘addictive’ and analgesic properties. However, it is notable that kratom alkaloids are derived from a coffee-like, not opioid-like, plant and display both opioid and stimulant properties, with stimulant effects predominant at low-to-moderate doses and opioid effects presenting with higher doses. In fact, it is the mixed opioid/stimulant profile of kratom that makes it so pharmacologically intriguing, and it is the stimulant properties, likely resulting from enhanced adrenergic transmission, that are especially understudied and a principal focus of our proposal. Information about kratom pharmacology remains mostly anecdotal, with the scientific literature lacking experimental details about the pharmacological effects of individual kratom alkaloids, especially as related to mechanisms underlying neuroprotective efficacy and abuse liability. To address this gap in preclinical knowledge, we provide the first comprehensive study of a kratom alkaloid (mitragynine) in preclinical models of chemotherapy-induced neuropathic pain and self-administration (SA) and to define neuroprotective and reinforcing efficacies of mitragynine (MG) in terms of receptor mechanisms, sites of action, and relative potency versus established drugs. We chose neuropathic pain as an endpoint because: (i) MG is already known to be antinociceptive in acute thermal pain models (hot plate and tail-flick) through opioid receptor activation; (ii) chemotherapy-induced neuropathic pain frequently causes cancer patients to discontinue medication; and (iii) MG has a favorable profile suggestive of anti-allodynic efficacy and neuroprotection. MG produces CPP, but the literature is devoid of SA data on reinforcing and motivational efficacy. Thus, we also propose SA experiments to assess the reinforcing and motivational strength of MG and identify underlying mechanisms. The overall hypothesis to be tested is that MG displays protection against chemotherapy-induced neuropathic pain through a mechanism that is dependent on α2-adrenoceptor activation in the spinal cord and displays reinforcing and motivational effects through mu opioid receptor activation that facilitates acquisition and maintenance of MG intake in SA assays. Strong preliminary data showing that MG elevates pain threshold against oxaliplatin-induced neuropathic pain is strongly supportive of our hypothesis.

Location: HSC: In-person essential
Student Majors Desired: Neuroscience, Biology, Chemistry, Biochemistry, Psychology
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Willing to conduct behavioral research in rats, mice and invertebrates (planarians). Interest in studying mechanisms underlying drug addiction, identifying new therapeutic approaches for addiction and pain.

Scott Rawls
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LKSOM Center for Substance Abuse Research/Pharmacology
Role of Kallikrein-kinin system in systemic and neulupus

How does airway epithelium contributes to pathogenesis of chronic obstructive pulmonary disease (COPD). Epithelium lining the conductive zone is the first line of defense against inhaled pathogens, particulates and other environmental pollutants. Airway epithelium which was initially thought to be physical barrier separating the environment from the lungs and to clear the inhaled pathogens via mucociliary escalator mechanism, is now recognized as an active participant in detecting inhaled pathogens and orchestrating innate and adaptive immunity in the lungs. Therefore alterations in structure and function of airway epithelium that is often observed in patients with COPD and asthma may significantly affect the outcome of respiratory infections. Rhinovirus which causes common cold in healthy individuals exacerbates disease in patients with COPD and asthma and also increases risk for acquiring secondary bacterial or viral infections. Our research is geared towards understanding the innate immune responses of airway epithelium to rhinovirus and how it affects the subsequent innate and adaptive immunity to secondary infections in COPD.

Location: HSC: In-person essential
Student Majors Desired: All majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Willingness to work with small animals, such as mice; Good organizational skills; Good writing and communicational skills.
Role of STIM-dependent calcium signals in T cell differentiation

T cells are critical players in adaptive immunity. T cells are made in the thymus and then released into peripheral blood where they seek out foreign agents. One of the first events that occurs in T cells when activated is a change in cytosolic calcium concentration. These calcium responses drive their differentiation into multiple differentiated T cell subsets that control the immune response in a manner dependent on both the duration and intensity of the calcium signal. We utilize a combination of cell lines and mouse models to understand the molecular events in control of calcium signal generation and T cell differentiation. This project would involve working closely with senior investigators in my lab, with the potential to learn multiple research approaches. Some prior students have earned publications.

Location: HSC: In-person essential
Student Majors Desired: Biology, Biochemistry
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Student must be enthusiastic with a genuine interest in learning research. Prior lab experience would be highly desirable but not required. Project involves cell culture, Western blots, cloning and fluorescence microscopy.
Spinal control of motor output

The Spinal Neuromotor Laboratory seeks to better understand how the spinal cord controls movement. To accomplish this, we use a wide variety of approaches and models to better understand the activity of the central nervous system. One of the main approaches we use is to record the electrical activity of skeletal muscle and decompose this information into the discharge of several dozens of individual spinal motoneurons. Recent technological advances have allowed us to record these detailed neuronal firing patterns noninvasively in humans using high-density surface electrode arrays. This approach has opened up several new avenues of research; not only can we record from a large number of neurons but we are now able to perform these detailed analyses in a wider range of subjects, including children, and in more relevant environments, including the home or hospital setting. This state of the art human work is paralleled by animal investigations in which we are able to perform more invasive recordings, such as recording the discharge of spinal interneuron populations using intraspinal microelectrode arrays. Our work is highly collaborative and we have active projects with our local, national, and international colleagues. The new knowledge we produce regarding the spinal control of movement is focused on developing life-changing therapies for individuals with disorders of the peripheral or central nervous system. Depending on their level of skill and enthusiasm, undergraduate students will take part in all aspects of this research from the data collection to analysis and dissemination.

Location: Main: Virtual to start, but could shift to in-person if the University approves
Student Majors Desired: Neuroscience, Engineering, Mathematics, Biology, Kinesiology
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Students are expected to assist with computer programming - they do not need to know how to code, but will be taught.

Christopher Thompson
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CPH
Health and Rehabilitation Sciences
**Myeloid cell responsiveness to cardiac injury**

We are investigating the impact of altered receptor expression/signaling in myeloid cells on their responsiveness to cardiac injury. The URP student will be involved in assessing markers of cardiac injury and remodeling via immunohistochemical and biochemical/molecular biology assays.

**Location:** HSC: In-person essential  
**Student Majors Desired:** Biology, Chemistry  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Previous research lab experience a plus.

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**The role of ADGRs in the heart**

We are investigating the impact of a new class of receptors, adhesion G protein-coupled receptors, on cardiac function and remodeling during heart failure. The URP student will be involved in analyzing echocardiography data for function and immunohistochemical and molecular biology readouts will be used to assess remodeling parameters. Some in vitro work to assess receptor activity/responsiveness may also be pursued.

**Location:** HSC: In-person essential  
**Student Majors Desired:** Biology, Chemistry  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Previous research lab experience a plus.
### Online eye tracking

Student will be working with the PI and other members at the Center for Applied Research in Decision Making to develop methodologies for online data collection. Specifically, the student will explore the use of webcams for tracking eye gazes, which will then be used to provide additional insights into the decision-making process. If possible, student will relate online eye tracking to physical eye tracking responses collected in lab.

**Location:** Main: Virtual to start, but could shift to in-person if the University approves  
**Student Majors Desired:** CIS Majors  
**Class Preferences:** Freshmen & Sophomores  
**Important Selection Criteria:** The position will involve a lot of coding in Java and Python. The position may also involve development of familiarity with physical eye-tracking and neurophysiological systems at the Center for Applied Research in Decision Making if in-person research is

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### Study sexual dimorphism of metabolic disease

Multiple projects. Studying how elevated androgen regulates metabolic function (brain, liver, adipocytes) and reproductive function (pituitary and ovary), using mouse model to mimic human disease such as transgender female and polycystic ovary syndrome.

**Location:** HSC: In-person essential  
**Student Majors Desired:** Biology  
**Class Preferences:** Sophomores & Juniors  
**Important Selection Criteria:** Motivation and responsibility
**Molecular control of vascular remodeling and lymphangiogenesis**

One of our lab's research focus is to identify novel signaling pathways that regulate vascular angiogenesis and lymphangiogenesis, one of the major cardiovascular problems. Reticulon family proteins (RTN) are mainly localized to endoplasmic reticulum (ER) and regulate mitochondria associated ER membrane (MAM). In this project we are using genetic modified animal models, cellular and molecular techniques to uncover how Nogo-B, the only RTN-4 family protein expressed in vessel wall, regulate MAM remodeling in endothelial cells, and vascular and lymphatic angiogenesis in diabetes.

**Location:** HSC: In-person essential  
**Student Majors Desired:** Biology, Biochemistry, or Pharmacology  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Highly motivated and responsible. Basic cell and molecular biology techniques and understanding of human physiology are a plus.

**Targeting cardiac fibrosis**

Chronic ischemia induced tissue fibrosis contributes to numerous end-stage diseases. Moreover, endomyocardial biopsy specimens from patients with atherosclerotic coronary disease-induced ischemic cardiomyopathy demonstrated 45% of replacement fibrosis. Thus, identifying the signaling cascades that regulates fibrosis in chronic ischemic diseases will have significant clinical benefit. In this project we will use a newly established chronic ischemia-induced cardiomyopathy model to: (1) interrogate the role of a novel signaling pathway that regulates ischemia-induced tissue fibrosis, (2) uncover the molecular mechanisms of its regulation of pro- and antifibrogenic signaling cascade, and (3) test the therapeutic potential of a newly developed allosteric inhibitor against fibrosis in vivo. The success of proposed study will define a drug target-able pathway in regulating chronic ischemia-induced tissue fibrosis. The successful candidate, who has previous lab experience, will have chance to conduct a part of the project and contribute to research article.

**Location:** HSC: In-person essential  
**Student Majors Desired:** Biology, Biochemistry, or Pharmacology  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Highly motivated and responsible. Basic cell and molecular biology techniques and understanding of human physiology are a plus.