Maximizing Access to Research Centers (MARC)

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Leamon Crooms

University of Arizona; Biology emphasis in

Biomedical Sciences

Mentor: Dr. Jil Tardiff – Biomedical Engineering

Identifying the Role of CaM kinase II in Cardiac Hypertrophy

ABSTRACT: Hypertrophic Cardiomyopathy (HCM), is a genetic heart disease and the third leading cause of heart failure in the U.S. CaMKII plays a role in both normal heart function as well as pathologic hypertrophy. CaMKII possesses the ability to activate itself when exposed to high calcium concentrations and we have found that specific mutations in thin filament proteins cause abnormal auto-activation of CaMKII and subsequent signaling pathways. Abnormal auto-activation of CaMKII has been shown to cause hypertrophic cardiomyopathy. We aim to apply the TurboID system to answer the question: Is there a pool of CaMKII that can be localized to the myofilament?. The TurboID system is a labeling technique that identifies neighboring proteins through proximity-dependent biotinylation. The goal of this project is to localize a population of CaMKII to the myofilament, which will enable us to target this population when and where it becomes abnormally activated in HCM.

Sydney Field

University of Arizona; Microbiology

Mentor: Dr. Marc Verhougstraete – Public Health

Gastrointestinal Epithelial Cell Response to Inorganic Arsenic Consumption

ABSTRACT: The consumption of inorganic arsenic through contaminated drinking water poses numerous threats to human health leading to acute and chronic health conditions such as diabetes, hypertension, and internal cancers. Throughout rural Arizona, unregulated water is used as a primary drinking water source and is subject to contamination by naturally occurring heavy metals such as uranium, lithium, and arsenic. Nearly 1/3 of Arizona's population is Hispanic and 25% live in rural communities. This population exhibits increased stomach cancer rates suggesting a connection between consumption of drinking water contaminants and gastrointestinal cancers. This study will focus on examining the effects of one contaminant (e.g. inorganic arsenic) on gastrointestinal epithelial cells by using a model capable of quantifying the effects of a single contaminant. Gastric organoids will be exposed to four concentrations of sodium arsenite (e.g. 0.005 mg/L, 0.010 mg/L, 0.02 mg/L, and zero), based off of U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) standards. The results will be analyzed using a one-way ANOVA in a randomized block design. Expected results for this study predict that inorganic arsenic concentrations twice that of the EPA MCL will exhibit higher rates of tissue necrosis compared with inorganic arsenic levels that are half of the MCL. If these results hold true, this would establish a method to distinguish the effects of multiple contaminants on gastrointestinal health and potentially explain the high rates of gastric cancer exhibited in some of Arizona's rural, underserved communities.

Jessica Graham

University of Arizona; Biosystems Engineering, Statistics and Data Science

Mentor: Dr. Bonnie Hurwitz – Agricultural-Biosystems Engineering

Viral and Bacterial Signatures in the Gut Microbiome Associated with Colorectal Cancer

ABSTRACT: Despite eukaryotic and bacterial viruses being associated with many cancers, cancer microbiome studies have almost exclusively focused on the bacterial communities of the gut microbiome. This study evaluates the virome of colorectal cancer, a leading cause of cancer related deaths throughout the world. The association between the gut virome and colorectal cancer is not well studied or understood. Datasets from previous studies that focused on evaluating the bacterial community composition of colorectal cancer were used in order to identify viral signatures. A total of eight metagenomic projects containing stool samples from colorectal cancer and healthy patients were analyzed and screened for viral sequences, and the diversity and composition of these viral communities was assessed. Viral contigs were retrieved from the assembly using a set of bioinformatic tools including Vibrant, VirSorter, VirFinder, and MARVEL. Viral operational taxonomic units (vOTU) were obtained by clustering sequences sharing 95% identity on more than 75% of their length, and taxonomic classification of the viral sequences was obtained using marker genes. A machine learning model was developed using the cumulative dataset containing healthy and colorectal cancer positive samples. The goal of the model is to be able to differentiate colorectal cancer viromes from samples. This study aims to further develop the understanding of the viral causation of colorectal cancer as well as recognize the biological role of viruses in the progression of the cancer. Additionally, the study evaluates the effectiveness of identifying colorectal cancer from samples using a machine learning model.

Aaron Judkins

University of Arizona; Plant Sciences

Mentor: Dr. Monica Schmidt – Plant Sciences

The Addition of Carotenoids to Brassica Napus for Enhanced Human Health

ABSTRACT: Brassica napus is a popular plant that is manufactured into canola oil, a popular vegetable oil used for cooking. Due to its frequent use as an oil in food production, it is a candidate for enhanced carotenoid content. This paper contains a literature review, methods, and a discussion section. The literature review explains what carotenoids are, how they benefit humans, and how they affect plants. The methods describe how carotenoids are added to brassica napus. Increasing carotenoid content in brassica napus is performed through the insertion of transgenes crtB and crtS to the plants. The crtB gene causes the overproduction of beta-carotene and crtS gene allows the plant to transform beta-carotene in astaxanthin which the plant did not originally contain. The plants will then be analyzed to determine if the genes were successfully added to the plant, gene expression will be observed at the RNA level, then the carotenoid levels will be quantitated. The goal of this research is to determine if carotenoids can be added to brassica napus to reach real world, beneficial levels. This paper covers how carotenoids benefit plants and humans, how carotenoids are added to brassica napus, and the ways this research will be conducted in the future.

Shane Mustafa

University of Arizona; Neuroscience and Cognitive Science

Mentor: Dr. Art Riegel - Pharmacology

Targeting Serotonergic Receptors in PFC as a Treatment for Substance Abuse Disorder

ABSTRACT: Due to the inconveniences that COVID-19 has caused, I was not able to conduct this project over the summer. This paper provides a framework to use moving forward in the upcoming fall semester to investigate the role of serotonin in the PFC to study addiction. SAMHSA (Substance Abuse and Mental Health Services Administration) indicates that a firm population of young adults abuse cocaine. Multiple literature presents a possible mechanism underlying substance abuse. Cocaine abuse results in decreases of dendritic branches and spines in the mPFC by decreasing glutamatergic subunits (Caffino et al. 2019). Cocaine use also induces the activation of the brain's natural stress response, which leads to decreases in dendritic branching and spine density (Radley et al. 2015). Research has shown that using an antagonist on the 5-HT2a subunit receptor results in decreased drug cravings in rats (Sholler et al., 2015) Psychedelics like lysergic diethylamide (LSD) and psilocybin act as an antagonist on the same serotonergic receptor but research shows these substances increase dendritic spines, synthesis of synaptic proteins and the strengthening of synaptic responses (Ly et al. 2018). The purpose is to promote the idea of using DREADDs to stimulate serotonin release to see if this can reverse the reduction in dendritic branching and spinogenesis produced by cocaine self administration.

Anakaren Romero-Lozano

University of Arizona; Biomedical Engineering

Mentor: Dr. Elizabeth Hutchinson – Biomedical Engineering

Identification of in-vivo MRI Markers in a Ferret Model of Closed Head Brain Injury

ABSTRACT: Traumatic brain injury (TBI) is a common form of brain injury that can have life-threatening complications if left untreated. Magnetic resonance imaging (MRI) is a powerful tool for the detection of TBI and ferrets are an effective animal model to study TBI due to their brains' structural similarities to human brains. This paper addresses how MRI has been used to detect a variety of brain injury and disease in previous studies in a short literature review. The purpose of this study is to identify MRI markers in ferrets that have been given relevant closed head injuries (CHI) and associate the markers with relevant outcomes in humans. The ferrets in this study were given a CHI using the CHIMERA device (Namjoshi et al., 2014) and their brains were scanned using an optimized processing pipeline for mapping, registration and analysis (Hutchinson et al., 2019). Analysis has begun with 3ferrets and 4 regions of interest, finding that CHIs may have a significant effect on the tissue in the white matter and the brainstem. A severe CHI resulted in an increase in T2 values for the white matter and brainstem, and a mild CHI resulted in a decrease in T2 values for the white matter and significant increase for the brainstem. Large increases and decreases in T2 values serve as potential markers for edema and hemosiderin in humans. Further statistical analysis of the entire data set will continue in order to draw stronger and more accurate conclusions.

Carlos Urrea-De La Puerta

University of Arizona; Biomedical Engineering

Mentor: Dr. Minkyu Kim – Biomedical Engineering

Design Principles for Functional Protein Hydrogels for Tunable Biomaterials

ABSTRACT: Protein-based hydrogels consist of a polymer network that can mimic the structure and function of native tissue. Understanding the different protein monomers and their behavior once they are incorporated into a polymer network is essential to develop the desired mechanical properties of the biomaterials. This review determines crucial design principles to consider when developing an ideal hydrogel using protein polymers for health applications. Differences between physical and chemical crosslinkers, along with the current challenges to reduce topological defects and improve network homogeneity, are assessed. In addition, the use of unstructured and structured proteins in hydrogel design is evaluated to determine how individual protein biomechanics are translated into the polymer network. An overview of potential medical applications, like drug delivery and wound healing methods, helps transition into the next steps of the project. Future studies will use basic design principles to develop a wound healing matrix made of elastin-like polypeptides (ELP) fibers and cellulose with anti-microbial peptides attached and will be implemented for patients with diabetic foot ulcers.