2023 KEYS

17TH ANNUAL RESEARCH SHOWCASE

THE UNIVERSITY OF ARIZONA
KEYS
Research Internship

Dear Interns, Families , and Friends,

We are thrilled to celebrate another successful summer of the BIO5 Institute's KEYS Research Internship, and especially to honor the accomplishments of our 2023 KEYS class!

We are proud of the dedication and commitment from all 56 individuals who shared seven weeks of their summer with us! Their research experiences spanned a wide variety of scientific emphases and included intensive training; projects, both hands-on and virtual; data analysis; and computational modeling. Interns had the unique opportunity to actively participate in ongoing research by University of Arizona faculty and staff in areas like cancer biology, neurodegenerative and cardiac diseases, biomedical engineering, environmental impact, toxicology, and virology.

We would be remiss if we did not take the opportunity to sincerely thank our UArizona and BIO5 Institute researchers and staff. They welcome high school interns into their labs and provide exclusive opportunities for the students to explore and experience the excitement and realities of scientific research and discovery.

Our interns also learn from exceptional postdocs, graduate and undergraduate students in their respective labs, in addition to the KEYS crew and staff who mentor them throughout their internship and beyond. More than 150 people work collaboratively to ensure the success of KEYS each year.

We sincerely appreciate the ongoing support of our generous program sponsors and donors. Without your contributions, KEYS would not be able to support as many high school students as we can today. Thanks to you, students are engaging in world-class UArizona research before college, which very well may impact the trajectory of their college education to pursue a STEM career.

With our commitment to advancing next generation science and scientists, we are gratified to now count 687 students as KEYS alumni with the addition of this year's interns.

Congratulations KEYS class of 2023, and best wishes for what we know will be a bright future!

Sincerely,

Jennifer Kehlet Barton, Ph.D.
Director, BIO5 Institute Thomas R. Brown Distinguished Chair, Biomedical Engineering
The University of Arizona

Jessie Allen
Director, Communications and Marketing
BIO5 Institute

Lisa K Elfring, Ph.D.
Associate Vice Provost, Instruction and AssessmentSpecialist, Molecular and Cellular Biology
University Center for Assessment, Teaching, and Technology

Kelle Hyland
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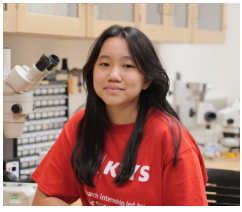


Alicia Bai

Expressing and Purifying Membrane Proteins

PI - Dr. Michael Marty

Membrane proteins comprise the majority of drug development targets; however, their insolubility makes them hard to isolate natively (Marty, 2020). This research aimed to express and purify the Respiratory Syncytial Virus (RSV) small hydrophobic (SH) protein and the Human Immunodeficiency Virus (HIV) viral protein unique (Vpu). We modified *Escherichia coli* cells for protein expression, filtered lysed-cell solutions with Immobilized Metal Affinity Chromatography, and obtained purified protein mass with native mass spectrometry and UniDec software. Since there were differences between SH protein's UniDec mass and its calculated protein mass, we conclude it was unsuccessfully isolated and plan to redesign its plasmid for increased durability during purification. Conversely, the successful purification of the Vpu protein enables investigations of its viral mechanism, ultimately leading to inhibitory vaccine development.

Adam Bedeir

Understanding the Relationship Between the Microbiome and Autism Spectrum Disorder

PI - Dr. Lingling An

This study investigated the microbial characteristics of children with Autism Spectrum Disorder (ASD) compared to a typical development (TD) control and each groups respective mothers. The study analyzed alpha diversity (richness and evenness), beta diversity (microbiome structure), and taxonomic analysis between study groups through QIIME2 analysis. ASD children had statistically significant differences in microbiome structure compared to both TD children and TD mothers. Mothers of ASD and TD children also exhibited significant differences in microbiome structure between themselves and their children. ASD children and ASD mothers had greater microbial richness compared to their TD counterparts. Additionally, specific bacteria differed in abundance across the groups significantly. These findings suggest distinctive microbial structures in ASD children that may ultimately help guide further research towards understanding ASD.

Lydia Behr

Validation of Microstructural MRI Markers in Alzheimer's Disease

PI - Dr. Elizabeth Hutchinson

Alzheimer's disease damages brain microstructure and affects memory, but research on the changes the brain undergoes can identify early diagnosis markers. My project aimed to validate observed MRI abnormalities in Alzheimer's brains using microscopy. Diffusion MRI shows water movement patterns, while microscopy reveals fiber orientation. Correlations between MRI and microscope images validate markers, as water movement relies on fiber alignment. I compared fiber coherency in microscope images to MRI scans of healthy and Alzheimer's brains to find corresponding patterns, validating the markers seen in the Alzheimer's MRI scans. Increased coherency was observed in two regions of interest in Alzheimer's brains. However, there was a lack of correlation between measured MRI and microscopy coherency which suggests the need for more specific markers to report findings accurately.

Madeleine Berry

Determining Brown dog tick preference for different dog breeds using petri dish assays

PI - Dr. Kathleen Walker

My specific research topic is analyzing if Brown dog tick host choice to canine hair samples can be used to identify which breed is more susceptible to brown dog tick infestations. Brown dog ticks can carry Rocky Mountain spotted fever (RMSF) which is a deadly tick-borne disease. These ticks infest human homes where they locate dogs to feed off. This creates major issues in communities that don't have readily available healthcare and veterinary care. With the results of my research, the information can inform the public on reasons whether the spread of RMSF can be related to the common dog breed found in those areas. Tick safety and monitoring these dogs can improve the tick infestation issue in mainly indigenous and rural areas.

Mazzy Bertram

Observing Study Participant Satisfaction Surveys at Week 1 to Increase Recruitment and Retention of At-Risk Participants

PI - Dr. Alicia Allen

Recruitment and retention of at-risk participants in research is a longstanding issue that negatively affects study accuracy and impact. Through an analysis of participant satisfaction surveys from the Observing Relationships between Caregiving and Hormones after Infant Delivery (ORCHID) study, we sought to discover what factors contribute to satisfaction by comparing moms with and without Opioid Use Disorder (OUD). We asked, “What are the differences in study satisfaction in participants with and without OUD?” to guide our research. Using data captured in REDCap, we completed a quantitative and qualitative analysis and found that participants most value compensation and relationships with compassionate staff. Future research should include these factors to promote increased participant recruitment and retention, enabling other studies to create meaningful change in the community.

Diya Bhattacharya

Is Apoptosis a Mechanism of Death induced by T.gondii in TINS?

PI - Dr. Anita Koshy

My research focuses on investigating the cause of cell death in Toxoplasma Injected Neurons (TINS) infected with *Toxoplasma gondii* (T. gondii) which is an intracellular parasite. Using a Caspase-3 Knockout (C3KO) mouse model and wild type mice, I aimed to determine if apoptosis, the most common pathway of cell death, is involved. Through immunofluorescence staining and brain sectioning, I compared the presence of TINS between the two groups. I found a higher number of TINS in the C3KO brains, suggesting that *T. gondii* is inducing apoptosis in TINS. These findings provide insight on how *T. gondii* persists in the brain and has implications for treating asymptomatic conditions and preventing neurological diseases associated with this parasite.

Kya Bruckner

Expanding the Scope of UA's PFAS Research: FHxSA as a First Example of High Resolution Mass Spectrometry Screening

PI - Dr. Leif Abrell

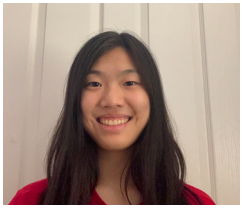
Per- and polyfluoroalkyl substances (PFAS) are long-lasting synthetic environmental contaminants. They are found in many consumer products and likely have adverse health effects. In order to expand the list of PFAS routinely measured at the University of Arizona, we ran water samples from around the state through a mass spectrometer. To verify the identities of the detected compounds, I cross-referenced the measured retention time, molecular mass, and fragmentation pattern of the compounds with those found in online databases. As a result, one PFAS compound was identified with high confidence. This compound, perfluorohexanesulfonamide, can now be added to the list of PFAS routinely measured and studied at the University of Arizona.

Micah Burt

Germanium Nanoparticle Synthesis and Modification For Photonic Devices and Materials

PI - Dr. Euan McLeod

Germanium is a metalloid with semiconductive and optical properties. My project is focusing on synthesizing germanium nanoparticles so they can be functionalized and have proteins immobilized on their surface. We ran a Dynamic Light Scattering (DLS) measurement to determine the diameter of the nanoparticles and the zeta potential. If the synthesis and functionalization of germanium nanoparticles is successful, proteins are allowed to be immobilized on their surface, then the germanium nanoparticles should be able to build nanostructures. These nanostructures will be used to improve the efficiency of optical sensors due to germanium's high refractive index.



Sophia Chen

Evaluation of Medication Use Pathways Relating to Cognitive Aging

PI - Dr. Bonnie LaFleur

Previous research has shown that cardiovascular disease (CVD) is associated with cognitive decline. We wished to investigate whether CVD medication provided a protective effect on the transition from normal cognition to mild cognitive impairment (MCI) in a group of participants who were followed for at least 5-years by the National Alzheimer's Coordinating Center (NACC). We used McNemar's chi-squared test and logistic regression to examine the trends in CVD medication use over time. We found higher prescription use in the group that did not transition to MCI and validated CVD history as an important covariate for MCI transition.

Annabel Close

Water Harvesting's Effects on Physiochemical Indicators of Soil Health in a Semi-Arid Urban Environment

PI - Dr. Laura Meredith

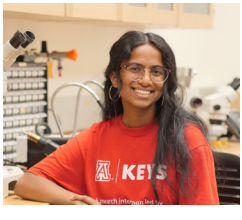
A water harvesting system was installed at an urban residence in 2017 to test the effects of both rainwater and human-originated water sources. One year post installation (Y1), the physiochemical properties of the soil at the site were measured and no significant divergence was observed (Buzzard et al., 2021). Now, we want to see if there are significant changes in these soil properties five years after installation. Once the soil was collected at three different depths, each sample was processed for physical (Gravimetric Water Content (GWC) and Bulk density (BD)) and chemical (Electrical Conductivity (EC) and pH) properties. Significant divergence was observed across some but not all treatment groups. From our findings, we can hope to improve urban water conservation and soil health.

Syriana Coronado

Culturing bacteria from Saguaro National Park to see how the microbes in the soil are reacting to the extreme climate the desert

PI - Dr. Malak Tfaily

We studied bacteria from Saguaro National Park (SNP) which are able to adapt to the harsh environment of their desert. Some of these bacteria within the soil grow faster and out-compete the slower bacteria for nutrients. Our goal was to make a media that would allow the slower bacteria to grow and be studied. To do so, we processed the soil from SNP to obtain organic carbon from the soil's natural bacteria and the soil itself. We found the slower bacteria grew more effectively in the media we made from the soil and the soil extracts than in a low-nutrient media, making this new media an effective tool for studying these bacteria.



Sahasrakshi Dasika

Evaluating the Effectiveness of Segment Anything in Plant Identification

PI - Dr. Haiquan Li

Dr. Li's lab is applying machine learning for plant and weed identification to protect native plants and preserve healthy biodiversity. My project looked at a new object segmentation algorithm, Segment Anything. During my work, I put images into the program, where it generated masks, or colored outlines around the individual recognized objects. These images involved various different perspectives and locations. The program was effective at recognizing brightly colored, large, or distinctly shaped objects, although small rocks, plants that blended in with the dirt, etc. were unidentifiable. Despite this, the low computational intensity encouraged the lab to continue using this model. Future efforts will focus on utilizing these masks to train a machine-learning model to first recognize saguaros, and later apply it to weed identification.

George Diaz

The Use of Electronic Health Records to Analyze Valley Fever and Pneumonia Patients

PI - Dr. Gondy Leroy

This study analyzed electronic health records of valley fever and pneumonia patients to address the uncertainty and anxiety caused by similar symptoms. Limited knowledge of valley fever among doctors leads to extensive testing without considering the specific valley fever test, increasing patient distress and costs. Using regular expressions, the presence of 10 symptoms was compared: fatigue, cough, fever, chest pain, muscle aches, shortness of breath, headache, night sweats, joint pain, and rash. More than 50% of patients experienced 8 out of the 10 symptoms. Notably, valley fever patients had a higher prevalence of night sweats compared to pneumonia patients.

Lillian Dobbins

The Effect of a High Fat Diet on Inflammatory Signaling in the Mediobasal Hypothalamus

PI - Dr. Frank Duca

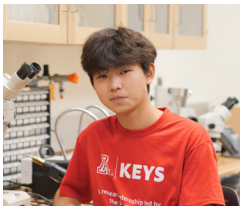
The brain communicates with the gut to control metabolic homeostasis and food intake. Consumption of a high-fat diet changes the gut microbiome and impairs gut-brain signaling pathways, such as Aryl Hydrocarbon Receptor (AhR)[1,2]. I examined how a reduction in AhR signaling contributes to the development of obesity and diabetes. The AhR pathway is hypothesized to suppress hypothalamus inflammation and prevent metabolic disease. To investigate this hypothesis, I used RNAscope and immunofluorescence to visualize inflammatory signals in the brains of control and high-fat diet mice. Comparison revealed that a high fat diet causes increased inflammation of the hypothalamus. Further examination will reveal whether this effect is due to AhR signal reduction. If so, then the AhR pathway could provide alternative treatments for metabolic diseases.

Ellie Dorland

Utilizing Artificial Intelligence in Epidemic Heatmapping and Data Visualization

PI - Dr. Tyson Swetnam

My project focused on the utilization of artificial intelligence (AI) tools, specifically Chat GPT to analyze epidemic-related data, with emphasis on COVID-19 and Cholera. The goal was to develop a reusable Python code capable of generating heat maps to identify areas of concentration or origin for epidemic outbreaks. The project employed a three-step process: using Chat GPT to generate Python code, publishing the code on GitHub for collaboration, and executing the code using Jupyter Notebooks for data analysis. The project aimed to integrate AI into the field of data science and foster a more accessible and collaborative scientific community. By embracing the potential of AI, the research sought to advance scientific inquiry, enhance data analysis, and promote an inclusive approach to understanding and combating epidemics.



Andrew Du

Exploring the Mechanisms of PKA Activation in Glycerol in Budding Yeast (*Saccharomyces cerevisiae*)

PI - Dr. Andrew Capaldi

Our research investigates the molecular mechanisms of glycerol-induced PKA activation in yeast cells. PKA, or protein kinase A, plays a vital role in cellular proliferation and growth. We aim to understand PKA functioning by introducing a specific modification to BCY1, the regulatory subunit of protein kinase in yeast. We hypothesize that glycerol activates PKA by impeding BCY1 through dephosphorylation via the TORC1 pathway. Through assays with glycerol and starvation media, we will observe the impact of these modifications on PKA activity and cell growth. Our research could uncover valuable insights into PKA activation and its implications for cellular proliferation. By shedding light on these molecular mechanisms, we aim to contribute to a wider comprehension of kinases and their significance in human health and disease.

Catherine Dunn

Using Imaging to Validate Traumatic Brain Injury Treatment

PI - Dr. Elizabeth Hutchinson

The goal was to determine if ultrasound is an effective treatment for traumatic brain injury (TBI). My role was to validate MRIs of mice brains with TBI through microscopy. I examined MRIs from four groups: control, TBI without treatment, TBI treated after a day, and TBI treated after a week. I took microscopy photos of stained samples, focusing on gray and white matter near the injury site. I examined the brains for irregularities in fiber geometry, which relates to the shape of fibers as water dissipates through the brain (Tournier, 2004). The results showed later treatment had a stronger effect, not reaching control levels. Ultrasound has potential to help regrow brain fibers. Further exploration the MRIs might show when ultrasound should be used for optimum treatment.

Leo Edgin

Understanding Environmental Impact on the Energy Distribution of G-Protein Coupled Receptors

PI - Dr. Michael F. Brown

The retina contains a protein called rhodopsin; a protein in the chemical messaging family, GPCR, which assists in low light vision. Its importance comes from it's linkage to afflictions including night blindness and neuro-degradation. Additionally rhodopsin is the largest GPCR subfamily making it an excellent reference for GPCR research. This asserts value in creating a physical model for the protein, while there are current models of the protein, none create consensus of the environmental impact on overall function of the protein. We created 5 models, each based on the previous, containing molecules significant to the protein's function. Models were subject to geometry optimization, stabilizing the molecular structure, then a Time Dependent Density Functional Theory calculation which output a UV absorbance graph. Model absorbances were compared to the currently accepted absorbances. The results from these comparisons indicate a correlation in the increased specificity of the models and convergence toward the experimental absorbance, creating precedent for further inquiry using this method.

Emma Edwards

Synergism of Osmotic and Heavy Metal Stress Response in *Caenorhabditis Elegans*

PI - Dr. George Sutphin

When organisms age, their cells encounter multiple simultaneous forms of stress. These cells respond to encountered stress by activating specific stress response pathways, which have the potential to interfere with each other or interact in some way. This can be demonstrated by the greater than expected lifespan reductions seen when stressors, such as NaCl and $CdCl_2$, are combined (Hull, 2023). I examined the presence of synergistic effects on *C.elegans*, microscopic worms, life spans via exposure to heavy metal and high salt concentrations such as NaCl, $CdCl_2$, and arsenic, in combination. $CdCl_2$ and NaCl, in combination, experienced the greatest decrease in lifespan. By identifying these interactions, we can further drive research into the mechanisms behind them and how they help maintain cellular homeostasis.

Cameron Emens

Single-cell RNA analysis in skin of individuals with Hypermobile Ehlers-Danlos Syndrome

PI - Dr. Jennifer Andrews

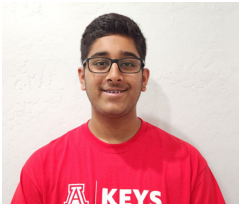
Hypermobile Ehlers-Danlos Syndrome (hEDS) is a condition characterized by joint hypermobility, skin elasticity, and chronic pain. No diagnostic test exists making diagnosis difficult. I analyzed single-cell ribonucleic acid (scRNA) of individuals with hEDS and unaffected controls to detect differences. We took a 3mm skin punch biopsy from participants and dissociated it into single cells. 10x droplet-based single-cell sequencing was performed, which allowed for the cells to be processed individually and cell-specific RNA sequenced. Cell clusters with similar transcriptional profiles were plotted with UMAP. We identified 9 skin cell types and found a significant difference in the proportion of 2 cell types in the skin of individuals with hEDS compared to unaffected controls. scRNA can detect differences in cell type proportions and improves understanding of hEDS.

Swanuja Godasi

Female Metabolism Before and After Seizure

PI - Dr. Michael Hammer

The Hammer lab studies a rare case of epilepsy caused by the SCN8A gene mutation using mice models. Using RNA sequencing, EdgeR, and Ingenuity Pathway Analysis (IPA) softwares, we determined that metabolic pathways were altered in females before and after seizure. I did a literature review and used IPA's Upstream Regulator Analysis to propose a model where females switch from using glucose to lipids after seizure as an energy rescue mechanism driven by their female-specific hormones. This theory could be tested by measuring estrogen and glucose levels and fluorescently tagging lipid-breakdown protein(s). These findings could aid in more effective treatments for female patients and support the current research highlighting the importance of energy metabolism in epilepsy.



Atharva Goel

Extracting Information From Video Using Deep Learning Methods

PI - Dr. Nirav Merchant

In the world of machine learning (ML), a new technology, video segmentation, has been advancing rapidly. This method uses deep learning (DL), a subset of ML, to identify objects, segment them (separate them), and track them throughout the video. My project involved creating a data pipeline in order to segment large amounts of video data using a generalized DL method. Once the most effective method was found, a data pipeline was created to process large amounts of video using that method. We expect the data pipeline to work as intended and segment large amounts of video data with a high throughput. Based on the pipeline's success, we can provide a powerful tool for researchers to segment and analyze videos effectively which has universal applications.

Julian Guerrero Teyechea

Warfarin Pharmacogenomics in a Hispanic & Latino Population: Copy Number Variation and Warfarin Dose

PI - Dr. Jason Karnes

Warfarin is a commonly used anticoagulant, but it's prone to adverse drug reactions. Large genetic variants where portions of DNA are deleted or duplicated, known as copy number variations (CNVs) may influence warfarin dosing. These modifications may vary among individuals and populations. Buccal cell DNA from Hispanic & Latino patients taking warfarin were used to detect CNVs in a region of interest on chromosome 6 (6q14.1) using a qPCR based TaqMan copy number assay (DNA amplification method). Results showed variability in copy numbers at locus 6q14.1. among individuals in the cohort. Despite differences in CNVs, no association was observed between copy number and warfarin dose requirement.

Shreya Guggilla

Examining Characteristics of the Hsp70 Chaperone Protein to Find Viable Drugs for Anticancer Therapy

PI - Dr. Eli Chapman

Chaperone proteins are vital for maintaining cell viability by preventing protein aggregation. However, cancer cells exploit these proteins to their advantage, so inhibiting them presents a viable strategy for anti-cancer therapy. My study focused on Heat shock proteins 70 (Hsp70s), a group of chaperone proteins. I conducted research on Hsp70s, focusing on their substrate binding. By transforming plasmids containing Hsp70 genes into bacterial cells and using metal affinity chromatography, I successfully purified Hsp70 from the cells. I created versions of the protein with and without a lid and examined their binding affinities to a peptide. The absence of the lid significantly enhanced Hsp70's binding affinity, suggesting the lid hinders binding. This discovery aids the search for Hsp70 inhibitors, furthering our understanding of potential therapeutic interventions.

Ella Harris

Do Bumble Bees Show Directed Exploration?

PI - Dr. Anna Dornhaus

This summer I worked with bumble bees (common western bumble bees *B. impatiens*) and their tendency to exploit or explore different known and unknown food sources. First the bees were tagged with a small number to see which bees are foragers (collect nectar and pollen for the hive.) The bees were then put through several assays (behavioral tests.) These were 2 sample phases where they learned information about the nectar concentrations in different colors of fake flowers and then 2 tests phases where the bee then was able to use their new knowledge to forage for the hive. I'm expecting to find that bees would prefer exploitation since, but my study was unable to be completed over the summer.

Sam Hershey

Data Reproducibility of Hands-Free Photoacoustic Skin Imaging System

PI - Dr. Russell Witte

Doctors need a convenient way to collect detailed information about a single region of skin over time to study the prognosis of skin cancers characterized by suspicious skin lesions. Recently, Dr. Witte's lab created a skin imaging device which provides detailed 3D data on the material composition of skin using both photoacoustic and ultrasound imaging. My project was to collect data with the device over multiple days to demonstrate its reliability over time by imaging a phantom skin model containing multiple different structures. The next step is to assess the device's data consistency across time using MATLAB. If we find this device can produce consistent and reliable information over time, it shows the device holds potential for clinicians in studying the progression of skin diseases.

Gina Horner

The Role of SvHMA5II in *Silene Vulgaris'* Copper Tolerance

PI - Dr. Alicja Babst-Kostecka

Dr. Babst-Kostecka's lab is focused on plants with unique tolerance to metals to use for mining site remediation. High tolerance to metals, or hypertolerance, can occur after local evolution, meaning different populations can have varying capabilities (Li et al., 2017). We looked at two populations of *Silene Vulgaris*, one with a hypertolerance to copper and one with a low tolerance. After treating the populations with copper, we will look at the expression of our target gene, SvHMA5II, to determine if it is related to high copper tolerance. This information can be applied to research on other plants that may have similar abilities to be utilized in remediation tactics.

Edwige Ishimwe

Investigating chaperon protein GroEL with/without Tails

PI - Dr. Marielle Wälti

The chaperone protein, GroEL, assists in folding other proteins and protects them from misfolding. Our research is focused on how the GroEL tails interact with other proteins when folded. We express GroEL in E. coli and purify it in the anion exchange column, Ammonium Sulfate precipitation, Size Exclusion Column, and Acetone precipitation. We visualize it by Cryo-EM (Cryo-Electron Microscopy) and analyze the images in a Relion program. We utilize NMR (Nuclear magnetic resonance) to display data as peaks and analyze it in CPnmr (Collaborative Computational Project for NMR). Our results were SDS gel Images, Cyro-EM (Cryo-Electron Microscopy) images, and CCPnmr peaks of GroEL with/without tails. We concluded GroEL with tails has more peaks than GroEL without the seats. The new peaks are possibly the tails.

Zella Johnson

How to Count Wasp Neurons

PI - Dr. Wulfila Gronenberg

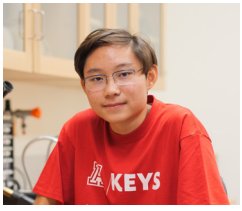
Most neuron-counting research has been conducted on mammals, birds, and reptiles, which is why my project hoped to expand research into wasp brains and neuron numbers. Without accurate knowledge of neuron concentrations, science cannot accurately consider neural function and behavior of these wasps. My project used Paper Wasps (*Polistes arizonensis*) to compare neuron-counting methods. Using the traditional method of counting individual cells cannot be distinguished from one another. Using Isotropic Fractionation (IF) to count the cells may provide a solution to this as it utilizes a dissociation solution to disrupt the cell membrane while keeping nuclei intact. I expect to have significantly different neuron numbers between the methods due to differences in the likelihood for miscounting.

Elysa Kan

Determining How Modulating the Inflammatory Response in Salivary Glands Post-Radiation Treatment Affects Wound Healing

PI - Dr. Kirsten Limesand

Currently, the standard of care for head and neck cancer patients entails surgery followed by radiotherapy, often leading to permanent salivary gland damage. This project investigated whether modulating the inflammatory aspect of wound healing can restore salivary gland function. We hypothesized that adding Interleukin-6 (IL-6), a pro-inflammatory signaling protein, to salivary gland tissue cultures would decrease proliferation and increase differentiation, both of which are correlated to better glandular function. Thick tissue slices were employed to recapitulate the response in mice, with immunofluorescence imaging used to detect any changes. Our results partially supported our hypothesis, showing a statistical change in differentiation but not proliferation after adding IL-6 in irradiated samples. Future research will explore the impact of different immune cells on the salivary gland's wound-healing response.



Andrew Kang

Comparison of Optical Coherence Tomography Imaging to Histology at the Uterotubal Junction

PI - Dr. Jennifer Barton

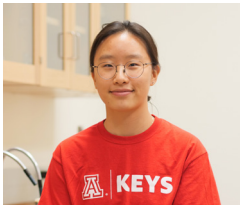
The uterotubal junction (UTJ) is the transitional segment between the uterus and fallopian tubes and is thought to serve a protective role against endometriosis. The structural integrity of the UTJ can potentially be evaluated using optical coherence tomography (OCT), a high-resolution optical imaging modality. The goal of this project was to characterize the morphology of one UTJ sample on OCT and histology. Following imaging, the UTJ was embedded, sectioned, stained with H&E, and examined using a light microscope. Our comparative analysis of histology to OCT images demonstrated that OCT can effectively show changes in the morphology and relative size of epithelial and muscular layers as the UTJ transitions from uterus to fallopian tube. Characterizing the UTJ structure on OCT is the first step toward detection of structural alterations in women with endometriosis.

Alyssa Kanies

Conservation of Mountain Gorillas in Uganda through Monitoring Microbiome, Genetics, and Ecology using Non-Invasive Methods

PI - Dr. Melanie Culver

Mountain gorillas (*Gorilla beringei beringei*) are an endangered subspecies of eastern gorilla. DNA can be collected non-invasively from scat to inform conservation about gorilla genomic diversity, heredity, relatedness, diet, parasite load, and more. Our research goal is to learn if ethanol or RNA Later are equally suited to preserve DNA. To do so, we have scat samples where a portion of each scat was preserved in ethanol, and the other portion in RNA Later. We then performed DNA extraction and used a control for contamination. We quantified DNA using a fluorometer and found that the RNA Later samples contained on average almost one hundred fold more DNA than the same samples preserved in ethanol. These findings assist our collaborators.



Emma Kim

Weight Loss is Coupled with Elevated Lipid Catabolism in a Mouse Model of Alzheimer's Disease

PI - Dr. Fei Yin

Mitochondrial metabolism reprogramming is involved in Alzheimer's disease (AD) development. While a correlation between body mass and cognitive decline in AD patients has been suggested, the mechanisms underlying AD-related weight loss remain unclear. We investigated Ucp1, Cox8b, and Atgl genes associated with mitochondrial energy expenditure in adipose tissue to confirm body weight loss as a risk factor in AD development. We performed real-time polymerase chain reaction (qPCR) with white adipose tissue samples to measure gene expression in wild-type and AD groups. Ucp1 expression was significantly higher in the AD model, indicating increased mitochondrial activity. Moreover, Atgl expression increased in AD, suggesting enhanced lipolysis, or lipid breakdown. Our study explores the potential mechanisms linking body weight loss, altered mitochondrial metabolism, and cognitive decline in AD.

Jacquelyn Kinman

Genomic Analysis of Patients with Dysautonomia

PI - Dr. David Harris

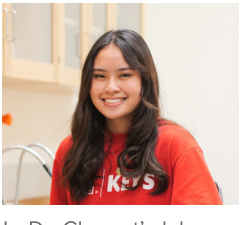
Dysautonomia is an autoimmune disorder within the Autonomic Nervous System (ANS), which goes to every part of your body and controls your sympathetic (conscious) and parasympathetic (subconscious) actions. Dysautonomia occurs equally in every demographic. We tried to find a genetic mutation that correlates with the diagnosis of dysautonomia. Our methods were researching dysautonomia, creating a survey based on our research, and analyzing patient genomes with their survey data to find any genomic connections. No data was collected, however we expect a genomic connection. The majority of patients who will be analyzed have already been diagnosed making future analysis easier and faster. If we do find a genomic connection, it will allow for straightforward diagnosis and new treatments.

Katherine Lam

Characterization of Novel Gene Regulators of TDP-43 Abundance in *S. cerevisiae*

PI - Dr. Ross Bucan

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease characterized by progressive muscle weakness and fatal respiratory paralysis. Previous studies have implicated the toxic protein TDP-43 in ALS pathology; however, little is known about healthy cells' mechanisms of TDP-43 clearance, which could theoretically be targeted to improve ALS patient outcomes. We evaluated TDP-43 abundance and cell proliferation rates in genetically manipulated yeast (*S. cerevisiae*) to characterize the relationships between TDP-43 accumulation, cell viability, and "ordinary" biomolecular pathways, indicating the genes RCY1, UBP1, and UBA4 as regulators of TDP-43 toxicity. Our findings also implicated disruptions to three homeostatic pathways–endocytosis, ubiquitination, and urmylation–as factors in ALS progression, indicating the corresponding mechanisms in human cells as potential targets for future treatments.



Trinity Le

Role of Phosphorylation of the Chemoattractant Receptor cAR1 on its function in *Dictyostelium* Chemotaxis

PI - Dr. Pascale Charest

In Dr. Charest's lab, we aimed to add phosphates to the receptor cAR1 protein by undergoing phosphorylation to mutate it and see its role in *Dictyostelium* cells. We attempted to create artificially-designed segments of DNA (DNA construct) to carry site-directed mutagenesis (creating mutants) through DNA cloning. We expected the outcome of the DNA construct to consist of Blue Script Plasmid (circular piece of DNA) containing Wt-cAR1 (target gene). Once this plasmid transforms into bacteria, it could be used to make more plasmid DNA or be expressed and make protein. We found our plasmid doesn't contain the target gene, possibly due to unsuitable plasmids or primers. The goal is to maintain our target plasmids, make more, express them in *Dictyostelium*, and finally characterize the cell's phenotype.

Larissa Limesand

Optimizing a drug screen to identify therapeutic treatments for HCM

PI - Dr. Jil Tardiff

Hypertrophic cardiomyopathy (HCM) is a prevalent cardiac disease [1] that commonly manifests in impaired relaxation of the heart [2]. The focus of my research is to optimize a drug screen that can identify small molecules that mimic the natural relaxation of the heart, which is regulated by structural changes in the protein cardiac troponin I (TnI) [3]. We tested three different fluorescent probes (IANBD, FMAL, and TMR) on two different regions of TnI (TnI A17C and TnI A28C) looking for the combination most sensitive to structural changes. TnI A28C labeled with the fluorescence probe IANBD had the most consistency and greatest difference in lifetime fluorescence. The optimization of this drug screen will allow for the development of future therapeutic treatments for patients impacted by HCM.

Chanae Lopez

Purification of Chaperone GroEL to Investigate the Importance of the Tails

PI - Dr. Marielle Wälti

Proteins play crucial roles in biological processes, their structure is essential to their function. Our research explores GroEL (protein chaperone in bacteria) and Hsp60 (protein chaperone in humans) proteins' assembly and functionality in protein folding. My research aims to comprehend how GroEL's tails contribute to protein folding. Dysfunctional Hsp60 is implicated in misfolded protein accumulation in the brain, contributing to Alzheimer's progression. Investigating the underlying causes and association with Alzheimer's is crucial. Our research utilizes protein purification and NMR (Nuclear Magnetic Resonance) to investigate GroEL's properties. The data confirms successful purification of GroEL, identifying a tetradecamer structure (14-rings). Our NMR analysis provides insights into GroEL's amino acid tails on a spectra to connect to the sequence. These findings enhance our understanding of protein folding mechanisms and contributes to elucidating interactions between chaperones and Alzheimer's.

Adrian Matzkin

Using NIRS to Determine Quantity of Bloodmeals in *Aedes aegypti*

PI - Dr. Michael Riehle

Mosquitos, such as *Aedes aegypti*, can carry diseases like Dengue and Zika. Mosquitos must acquire these diseases from blood feeding on infected humans. This means that as a mosquito obtains more blood meals, they are more likely to carry a mosquito-transmitted disease and infect people. My research question is whether it is possible to determine the number of blood meals a mosquito has through an NIRS (Near Infrared Spectrometry) scanner. My project entailed prepping and scanning mosquitos and using machine learning to create an accurate model that can predict the number of blood meals a mosquito had. We expected to be able to make a strong model to predict the number of blood meals a mosquito has. This process will help mosquito control organizations better protect communities from mosquito-transmitted diseases.

Hannah Mendoza

The Importance of Modeling Low-Coverage Sequencing on Demographic Inference

PI - Dr. Ryan Gutenkunst

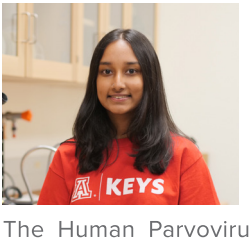
Low-coverage genome sequencing has emerged as a cost-effective approach, enabling the analysis of numerous individuals. However, this strategy can introduce bias in downstream analyses due to a reduction of heterozygous genotypes. Here, we tested a novel probabilistic framework designed to correct the distortion caused by low-coverage sequencing. To evaluate its accuracy, we examined simulated datasets representing an ancestral population size of 10,000 that underwent a population expansion to 100,000 individuals, 1,000 generations ago. These simulations were conducted using different mean coverage depths, specifically 3x, 5x, and 30x. We found that incorporating distortion resulted in a close match between the inferred and true demographic parameters. Conversely, neglecting to account for low-coverage sequencing significantly biases parameter estimation. Hence, accounting for low-coverage sequencing is crucial for accurately inferring demographic parameters.

Riya Nalla

Using Regular Expressions in Python to Analyze Valley Fever and Pneumonia Electronic Health Records

PI - Dr. Gondy Leroy

Valley fever, a respiratory condition endemic to the Southwestern United States, is often confused with other lung diseases early in the diagnosis process, leading to the dissipation of time and resources. Our goal was to make diagnosis more efficient by identifying differences between pneumonia and Valley Fever datasets. I applied regular expressions, or word coders, in Python to these Electronic Health Records (EHR), then compared the frequency of certain symptoms. I modified these regular expressions for the inclusion of related words in the EHR to encapsulate possible variations of the symptoms. My results showed significant discrepancies of more than 5% between pneumonia and Valley fever patients for certain symptoms: night sweats, especially, as well as arthralgia, chest pain, and fatigue. This implicates further research for the physiological differences between pneumonia and Valley fever.



Riya Nannapaneni

Investigating the Ability of a Novel Compound to Inhibit the Cleavage Activity of the Human Parvovirus B19 NS1 Nuclease Domain

PI - Dr. Nancy Horton

The Human Parvovirus B19 is a pathogenic virus that poses lethal symptoms for immunocompromised people. This project aims to use a novel compound to inhibit the cleavage activity of B19's NS1 nuclease domain responsible for viral replication. We used methods such as batch purification with Talon (cobalt) resin, anion exchange column chromatography (DEAE), and concentrating by filtration as steps toward isolating the NS1 nuclease domain. We used Western blots, Coomassie stains, chromatograms, and silver stains to verify that purification and concentration efforts were successful. Future directions entail size exclusion chromatography to eliminate any last contaminants and crystal trials to establish the best conditions for crystallization. Through this study, we can mitigate the harmful effects of B19.

Bernardo Navarro

Studying the Compressive Forces Attained and Retained between Bone and Screws

PI - Dr. L. Daniel Latt

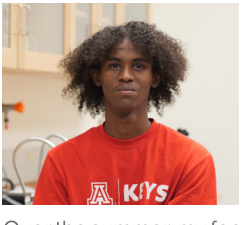
Bone fusion is a surgical procedure aiming to merge two pieces of bone through compression. However, Bone's viscoelastic properties allow for decompression, hindering fusion. Our study investigates the interaction between bone and screws by comparing the compressive forces achieved and maintained by three distinctive screw types. We utilized a system where a load cell measured the compression of cadaver bone segments during a series of screw-tightening and resting cycles. Findings indicate that the partially threaded screw initially achieved the highest compression but failed to maintain it as effectively as the double-threaded screw. The fully threaded screw, however, would yield no compression. This data aids surgeons in selecting the most effective screw choice in current procedures while also inspiring development in future medical hardware.

Larissa Navarro

Roots for Resilience: Developing Lettuce (*Lactuca sativa L.*) for a Hotter, Drier Tomorrow

PI - Dr. Duke Pauli

Lettuce is one of the most widely consumed fresh vegetables, and Arizona's most significant crop. However, sustainable production of lettuce is threatened by reduced water availability and increasing temperatures associated with climate change. For the continued production of lettuce, the breeding and development of new varieties that are more efficient with water usage is needed. Root system architecture (RSA) is a significant attribute and controls the acquisition of water and nutrients. To further our understanding of RSA, we identified and characterized the genes responsible for controlling key properties of lettuce RSA through a combination of field phenotyping and image analysis. With this information, lettuce breeding programs can select genotypes with favorable RSA to increase their ability to acquire and use water to produce plant biomass.



Ayanle Noor

Integrated Large Language Models for reproducible research

PI - Dr. Tyson Swetnam

Over the summer, my focus was on analyzing genome data sets to understand the diversity among different human samples. I utilized large language models, including ChatGPT, extensively in my research. The goal was to uncover the variations and differences between samples worldwide. By leveraging these models, we aimed to assess the accuracy of our findings. The research revealed significant differences among the samples, shedding light on the diverse nature of the human population.

Lauren Pfaff

Smart Tree Watering for Arid Landscape

PI - Dr. Laura Meredith

Arizona is currently affected by drought and water scarcity, which necessitates that we cut down our water usage to preserve our natural resources. The ABOR Tree Performance Project seeks to maximize the efficiency in irrigation systems in the tree establishment phase. Our experiment entails planting the trees with the different watering systems and measuring tree performance/soil health. So far, we have found that mulch and cellulose hydrogels are the best ways to maintain soil moisture in the ironwood trees. These results will have implications for sustainable desert landscapes and irrigation.

Charisse Qin

Impact of Residues and Water on Energy Absorbance of Rhodopsin

PI - Dr. Michael F. Brown

Rhodopsin is a G-Protein Coupled Receptor (GPCR) located in the retina, which detects dim light and transmits a signal to the brain (Hofmann et al, 2009). Current computational models of rhodopsin are underdeveloped, so our goal was to develop models to show the impact of the environment on energy levels of retinal, the chromophore that activates rhodopsin. We isolated retinal and surrounding residues (amino acids) to create models of varying completeness (up to 10 residues). After optimizing, we calculated the UV-Visible spectra of both the dark (unexposed) and active (exposed) state of rhodopsin. Adding water and having more residues caused a more experimentally accurate UV-Visible spectrum. We concluded that the environment plays a key role in determining the electronic environment of the retinal.

Sophie Richard

Effects of Oxygen and Glucose Therapy on Beta-Cell Area in FGR Sheep Fetuses

PI - Dr. Sean Limesand

Placental insufficiency (PI) lowers fetal blood oxygen and glucose concentrations, which causes fetal growth restriction (FGR). FGR fetuses have decreased glucose-stimulated insulin secretion and beta-cell area. Since oxygen-glucose supplementation improved insulin secretion in FGR fetuses, we hypothesized that beta-cell area is increased. We measured pancreatic insulin area in three experimental groups to test our hypothesis. Oxygen-glucose supplementation was administered to FGR fetuses to increase their concentrations, and this group was compared to the control and FGR fetuses. Pancreatic tissue sections were immunostained and insulin-positive areas were measured. Oxygen and glucose concentrations increased with supplementation but failed to increase insulin area, fetal weights, and placenta weights. Therefore, our ten-day treatment was too short to see a recovery in the beta-cell area despite finding greater insulin secretion.

Sabrina Russell

Developing a Hybrid Sensor for Electrochemical & Spatial Mapping of a Single Cell

PI - Dr. Craig Aspinwall

Detecting and mapping insulin secretion from a single cell is difficult. Previous experiments utilized carbon fiber electrodes for detecting insulin or explored Scanning Ion Conductance Microscopy (SICM) for mapping a single cell, but failed to measure the quantity of secretion (Aspinwall et, al., 1999; Bednarska et, al., 2013). My project focused on developing a hybrid sensor capable of electrochemically and spatially mapping insulin secretion from a single cell. We fabricated a double-barrel quartz pipet with one barrel pyrolyzed to detect insulin by electrochemical oxidation and the other for SICM spatial imaging. However, challenges arose when using the double-barrel pipet for SICM due to the oblong shape of the barrel. Further research aims to overcome these challenges so SICM and insulin detection can be done simultaneously.

Arwen Showman

Using Total Renal Denervation to Mitigate the Effects of Polycystic Kidney Disease

PI - Dr. Christopher Banek

This summer I worked in Dr. Banek's Physiology lab, which investigates polycystic kidney disease (PKD), a genetic disorder where cysts form in the kidneys. I analyzed the effectiveness of the treatment total renal denervation (T-RDNx), a process that involves removal of nerve bundles from the kidneys, by measuring the cystic area and amount of fibrotic (scar) tissue caused by PKD in vertebrates with and without the T-RDNx treatment. Overall, the vertebrates with the T-RDNx treatment had less cysts and fibrous tissue than the vertebrates without any treatment. This suggests that T-RDNx limits the effects of PKD. There is currently no test to diagnose patients who would benefit from renal denervation, so further studies should be done to improve on T-RDNx and develop more effective treatments.

Nyreek Thompson

The Importance of Food-Based Antimicrobials against Food-Borne Pathogens

PI - Dr. Sadhana Ravishankar

Food-borne pathogens, like Salmonella and Listeria, can cause bodily harm and are a problem all over the world today. With research in labs around the world, cures or inhibitors, called antimicrobials, to these pathogens can be found. My PI Dr.Ravishankar and my mentor Dr.Libin work with food based antimicrobials to create safer antibiotics for our bodies and environment. We mixed different concentrations of antimicrobials derived from plant extracts with bacteria to find the concentration of antimicrobials needed to neutralize bacteria. We hope to create new plant based antimicrobials to fight against worldwide bacteria problems as a more natural alternative than chemical based antibiotics.

Christopher Ungaro

The Synthesis and Characterization of Magnets with Geometrical Frustration

PI - Dr. Tai Kong

Typically, magnetic atoms orient themselves either parallel or antiparallel to nearby atoms. When a magnetic atom within a triangular structure tries to align with its neighbors in an antiparallel fashion, it is unable to align to both simultaneously, becoming magnetically unstable, or frustrated (Ramirez, 1994). This project attempted to synthesize crystalline compounds whose complex structures may contain frustration. We synthesized CaNi2Zn3, which has a “ruby” structural pattern, and Y5Co2Sb, Y5Co2Bi, Lu5Co2Sb, and Y5Co2Sb, which have a Shastry-Sutherland structural pattern (Stojanovic, 2007). Synthesis was accomplished by chemically reacting elemental components at high temperatures, and the target materials were characterized via x-ray diffraction. If frustration is found, then it could be leveraged in the creation of novel materials like superconductors.

Avery-Shalom Valencia

Analyzing and Comparing Participant Satisfaction Surveys at Week 12 to Increase Retention and Recruitment in Research Studies

PI - Dr. Alicia Allen

The RENEW lab conducts a 12 week study, Observing Relationships between Caregiving and Hormones after Infant Delivery (ORCHID), which consists of daily surveys sent out via RedCAP (data collection software) and visits requiring blood withdrawals. I investigated how satisfaction differs in week 12 of the ORCHID study between participants with and without Opioid Use Disorder (OUD) using qualitative and quantitative methods derived from survey results. Response trends were then analyzed to conclude significant participant satisfaction factors in the ORCHID study. My results showed that participants were satisfied with compensation and supportive staff, while they weren’t satisfied with blood withdrawal and survey alerts. These analyses of participant satisfaction answers help aid retention and participation in future studies, proving significance in research contribution.

Sri Varun Vungutur

Comparing the Efficiency of a Hollow Core Fiber and a Quartz Multi Plate Setup for Pulse Compression

PI - Dr. Arvinder Sandhu

High-speed cameras have allowed humans to capture processes on timescales faster than can be observed with the human eye (10-3 seconds). Ultrafast processes, such as the motion of an electron, occur at attosecond timescales (10-18 seconds) and are too fast to capture. Instead, attosecond laser pulses acting as a shutter are required. In this project, long pulses from a Ytterbium(Yb) laser are compressed via two methods: (1) a gas-filled hollow-core fiber (HCF) and (2) multi-plate compression (MPC). An analysis of both methods were performed to assess the advantages and disadvantages of both techniques. Preliminary data suggests that the HCF allows for more pulse compression at higher pulse energies. While the MPC approach provides better stability and is easier to implement.

Zachary Wang

Evaluating Chronic Wireless Implantable Device Encapsulation Durability through Mechanical and Chemical Stress

PI - Dr. Philipp Gutruf

Wireless implantable devices (WIDs) must withstand the hostile environment of the human body, including bodily fluids, pH levels, biofouling (the accumulation of bacteria or proteins on the surface of a device), and movement. This research focuses on studying the impact of physical and chemical stress on the encapsulation material (PDMS) that mutually protects the device and the body. By subjecting PDMS to cyclical mechanical strain, we can observe its accelerated lifespan. These findings can help determine whether the WID encapsulation is reliable for long-term use in humans. The durability of WIDs and their encapsulation is crucial as it can minimize the need for regular assessments and maintenance, ensuring peace of mind and even saving lives by preserving optimal device performance.

Jake Weiss

Evaluating Metabolic Biomarkers in Transition to Mild Cognitive Impairment

PI - Dr. Bonnie LaFleur

Our study evaluated the use of metabolic markers as a pre-clinical measure of the transition to mild cognitive impairment (MCI). Using the Alzheimer's Disease Neuroimaging Initiative study, we defined two groups of participants who had four years of follow-up: those who remained cognitively healthy (n=133), and those who developed MCI (n=54). Using t-test statistics, we found several differences in metabolite concentrations between the two groups. Random forest analysis identified several potential metabolic biomarkers. Di- and triglycerides were of interest in males, while phospholipids demonstrated promise in females. These results support the utility of measuring metabolites in the early detection of cognitive impairment.

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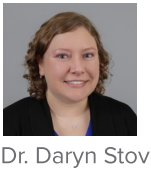
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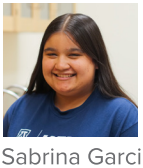
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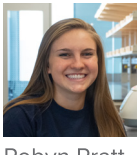
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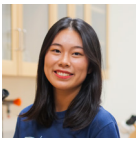
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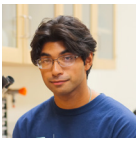
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