

# RICE UNDERGRADUATE RESEARCH SYMPOSIUM



**RURS 2023:  
Research Wrapped  
April 10 - 12th at RMC**



[ouri.rice.edu/rurs](https://ouri.rice.edu/rurs)



RICE UNIVERSITY

Office of Undergraduate  
Research and Inquiry

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# Letter from the Co-Chairs

Greetings,

We are elated to present the abstract book for the 2023 Rice Undergraduate Research Symposium (RURS). These pages highlight countless genres of Rice undergraduate research across many different fields and encapsulate student contributions to the understanding and advancement of our world. RURS serves as a platform for undergraduate researchers to exchange observations and knowledge outside of the classroom and to promote enthusiasm for the endless possibilities for inquiry available to them.

Our theme this year is “Research Wrapped”. When we chose this theme, our goal was to highlight this symposium as a way to summarize months- or even years-long work conducting research in the essence of Spotify’s annual summary of music streaming. Creating these posters and giving these oral presentations is only one part of the research process, and while near perfect, these presentations do not show the amount of title changing, thesis rewriting, literature reviewing, data collecting, data analyzing, and information synthesizing these students conduct. So, to our researchers, we hope this symposium allows you to wrap up this chapter of research so you can continue developing this project, start anew, or humming an entirely different tune. We truly believe that research allows students to grow as individuals and leaders and also enhances their undergraduate experience and such work deserves a place to be recognized. We hope that you too, when reading through this booklet, will be as inspired as we are by the fascinating research our peers are composing.

We would like to thank all of the faculty, students, and staff who make RURS possible. This celebration of scholarship would not be possible without mentors from within Rice and beyond who are dedicated to supporting student scholarship, promoting undergraduate research, and providing opportunities for inquiry.

Sincerely,  
Nafisa Azizi, Brendan Frizzell, and Hannah Li  
RURS 2023 Co-Chairs

# Office of Undergraduate Research & Inquiry

Stay involved with OURI! In this section, you can read about some highlighted undergraduate research programs at Rice and learn about additional opportunities at [www.ouri.rice.edu](http://www.ouri.rice.edu). OURI is housed in Fondren Library on the 5<sup>th</sup> floor, Office #514.



## **Peer Research Ambassadors**

Peer Research Ambassadors are Rice students who have engaged in research, design, and creative work during their undergraduate careers and want to help other students get involved. Ambassadors host office hours and attend OURI workshops and events in order to share information specific to their academic schools. They also serve as an advisory board, providing feedback to OURI staff on how to improve outreach efforts. Feel free to reach out to any of them or make an appointment with OURI to get matched!

## **UNIV 301**

This zero-credit course enables students to have supervised research experience on and off campus recorded on their transcript, and is repeatable for credit. The requirements for satisfactory performance need to be agreed upon between you and your research advisor at the beginning of the term. Note that your research advisor can be faculty on or off campus. OURI does not determine these requirements

## **Rice Undergraduate Scholars Program (RUSP)**

The Rice Undergraduate Scholars Program (RUSP) is a two-semester, for-credit program aimed at senior Rice students in all disciplines who are interested in pursuing a research career and planning a one-year senior research project through an honors thesis or independent study. Students attend weekly seminars on topics related to graduate school and research careers across sectors. The program is focused on developing research and presentation skills, an understanding of a research career, and how to apply to graduate school and nationally competitive fellowships. In addition, all students in the program receive funding that may be used for research materials or conference attendance.

## **Summer Undergraduate Research Fellowship (SURF)**

OURI Summer Undergraduate Research Fellowships, is a program for undergraduates from underrepresented backgrounds who are interested in pursuing supervised research with a Rice faculty member over the summer. No prior research experience is required, and preference will be given to first- and second-year students without previous experience. Students from all disciplines are eligible to apply. Fellows will receive \$5000 and are expected to work approximately 30 hours per week on their research project

### **Sustaining Excellence in Research Scholars Program (SER)**

Sustaining Excellence in Research (SER) Scholars are freshmen & sophomore students in the STEM (Science, Technology, Engineering, and Mathematics) disciplines who are invited to participate in the SER Scholars Program, based on a constellation of factors relevant to the student's academic preparation for the science and engineering course work at Rice. In the HHMI SER Scholars Program, students receive support to achieve academic excellence. They attend regular mentoring meetings with program staff, and are paired with a lab either within Rice or the Texas Medical Center, where they receive \$10.00 per hour for the first 150 hours of their work. In addition, there are monthly meetings and workshops to network with other Scholars and learn new study and stress management skills.

### **Mellon Mays Undergraduate Fellowship Program (MMUFP)**

The fundamental objective of the Mellon Mays Undergraduate Fellowship is to increase the number of minority students, and others with a demonstrated commitment to eradicating racial disparities, who will pursue PhDs in core fields in the humanities and social sciences. During their junior and senior years, fellows conduct research under the guidance of a faculty mentor and attend weekly meetings with the Mellon cohort and faculty and staff coordinators. Fellows receive a stipend to support their research.

### **Distinction in Research and Creative Works**

Distinction in Research and Creative Works is a university award for select undergraduates, granted at commencement, which appears on the transcript and diploma. Students must apply to be considered for the award, and the application must be supported by a letter from a faculty member (or Center director). The most common path of application will be to the student's major department. A student whose research or other creative project is in a field outside of his/her major should submit an application to the academic department or program most closely associated with the subject matter of their project.

# Shapiro Showcase Information

**Session I — Farnsworth Pavilion**

04/10/2023, 3:30pm—5:00pm

School of Engineering

## **Regionally Activated Interstitial Drugs for Brain Disorders**

Andrei Mitrofan | Mentor: Dr. Jerzy Szablowski

Neuropsychiatric disorders affect over 100 million people in the US alone and contribute to years lost to disability more than any other disease category. Despite the mechanistic understanding of the processes underlying regional brain dysfunction, neuromodulation with spatiotemporal precision over extended periods of time remains a major challenge. Current treatment methods involve small molecule drugs that penetrate the blood-brain barrier (BBB) and diffuse throughout the brain without spatial selectivity, resulting in nonspecific off-target effects. Recent studies have shown that spatially precise control of neuronal activity can be achieved with a combination of focused ultrasound blood-brain barrier opening (FUS-BBBO) and delivery of small molecule drugs or viral vectors carrying chemogenetic receptors for gene therapy, in an approach termed Acoustically Targeted Chemogenetics, or ATAC. However, small molecules delivered this way are only retained in the brain for minutes to hours, and their activity is confounded by the presence of the opened BBB. On the other hand, chemogenetic approaches such as ATAC allow for long-term activity, but can only be feasibly administered once due to the development of immune response against the vectors and are hampered by potential risks of viral toxicity. We propose a new paradigm called Regionally Activated Interstitial Drugs (RAID) that does not require viral vectors, but still allows for tunable, long-term neuromodulation with spatial selectivity. To achieve this, RAID relies on FUS-BBBO mediated delivery of an engineered enzyme into the brain which binds to the brain parenchyma and can locally convert a BBB-permeable inert prodrug into an active neuromodulatory drug. As long as the RAID enzyme is present in the parenchyma, localized neuromodulation can be achieved by systemic administration of a small molecule BBB-permeable prodrug, even in the absence of a BBB opening. Our proof-of-concept study demonstrated that the engineered RAID enzymes can retain activity in the brain for several days. We have also shown that RAID can produce local activation of dopaminergic neurons and elicit site-specific behavioral effects. The proposed RAID paradigm enables noninvasive, tunable, site-specific, temporally-resolved neuromodulation over multiple days.

## **Data Analytics Approach to Addressing Children's Mental Health in the Post-Pandemic Era**

Alison Qiu | Mentor: Dr. Su Chen

The COVID-19 pandemic has had a profound impact on individuals and society worldwide, and the US Census Bureau conducted the Household Pulse Survey since April 2020 to comprehend its impact on various demographic and socioeconomic factors. In this study, I developed data analytics pipelines to analyze the impact of COVID-19 on the mental health of the US population, with a focus on children under the age of 18. My research revealed a strong correlation between mental health status and certain demographic and socioeconomic factors. By assessing over 100 potential factors, I identified the factors that most significantly impact children's mental health outcomes. The significance of this research is twofold. Firstly, from a socio-political perspective, it provides insights into the critical factors that must be addressed to improve children's mental health outcomes in the post-pandemic era. Secondly, from a technological standpoint, I developed a reusable, accurate, and flexible data processing pipeline and prediction model that can be used to analyze future data from the Household Pulse Survey. These findings can inform public policy decisions that aim to provide better support for vulnerable populations in the post-pandemic era, such as providing housing assistance and the development of mental health interventions for specific populations. Ultimately, this research contributes to a greater understanding of the impact of COVID-19 on children's mental health and lays the groundwork for future research to address this critical issue.

## **An Efficient Multifeed Rectenna For RF Energy Harvesting**

Jack Tomkiewicz | Mentor: Dr. Taiyun Chi

This paper presents a multifeed rectenna for high-efficiency RF energy harvesting. By using a multifeed slot loop antenna and co-designing the antenna and the rectifier circuit, the lossy impedance matching network between the antenna and the rectifier is eliminated to boost the RF-to-DC conversion efficiency. Additionally, using multiple antenna feeds extends the high-efficiency region of the rectifier, which in turn, allows for high DC output power and high efficiency simultaneously. A proof-of-concept two-feed rectenna is designed and tested at 960 MHz. It achieves a peak efficiency of 64.5% and a combined DC output voltage of 1.72 V at an input power density of 2.3  $\mu\text{W}/\text{cm}^2$ , demonstrating state-of-the-art RF energy harvesting performance.



## School of Natural Sciences

### **Dynamic Control of Energy Transfer in AuNR-PANI Hybrids through pH**

Annette Jones | Mentor: Dr. Christy Landes

This paper presents a multifeed rectenna for high-efficiency RF energy harvesting. By using a multifeed slot loop antenna and co-designing the antenna and the rectifier circuit, the lossy impedance matching network between the antenna and the rectifier is eliminated to boost the RF-to-DC conversion efficiency. Additionally, using multiple antenna feeds extends the high-efficiency region of the rectifier, which in turn, allows for high DC output power and high efficiency simultaneously. A proof-of-concept two-feed rectenna is designed and tested at 960 MHz. It achieves a peak efficiency of 64.5% and a combined DC output voltage of 1.72 V at an input power density of 2.3  $\mu\text{W}/\text{cm}^2$ , demonstrating state-of-the-art RF energy harvesting performance. When excited with incident light, nanoparticles support localized surface plasmon resonances. The energy offered due to the plasmon's high cross-section absorption can be used in photocatalysis and photovoltaics to increase device efficiencies. Hybridization of nanoparticles with an interfacial energy acceptor has been introduced as a method to capture the charge or energy offered by the plasmon before the ultrafast recombination of electron hole-pairs occurs. Understanding the mechanisms occurring at the interface in hybrid materials is crucial for future optimized device implementations. Charge transfer is one viable mechanism for hybrid materials; however, it requires a scavenger layer to avoid charge imbalance, which leads to eventual dissolution and device degradation. Alternatively, resonance energy transfer offers an avenue for the use of soft polymer at plasmonic interfaces while relaxing the band alignment requirement and allowing for increased processability of metal-organic interfaces. Creating an electron hole-pair in the acceptor eliminates the possibility of charge accumulation on the metal. RET is achieved via dipole-dipole coupling and is most efficient when the spectral overlap between the plasmon donor and polymer acceptor is greatest. Polyaniline (PANI) is a semiconducting polymer with an absorption spectra that shifts across pHs, allowing the RET between AuNR and PANI to be switched on and off maximal efficiency. This project monitors RET efficiency via changes in the single particle linewidth. Single-particle data correlated across multiple conditions is achieved using a custom-built fluidic cell on an inverted hyperspectral dark-field microscope to collect plasmon spectra in both acidic and basic conditions. This work demonstrates how a tunable soft interfacial acceptor with an AuNR donor can achieve switchable RET as the PANI moves in and out of the region of maximal overlap. Since the single particle linewidth also relies on the morphology of the rod, this work also demonstrates how the degree of RET modulation achievable is reliant on the morphological properties of the individual rod. These results open the possibility of specific AuNR morphologies to be selected in future AuNR-PANI devices to optimize desired electronic properties.

## **Skin Color Development and CRISPR Genome Editing in the Brown Anole Lizard (*Anolis sagrei*)**

Zoe Griffin | Mentor: Dr. Bonnie Kircher

Animal communication modalities are highly variable across species. In squamates (lizards and snakes), while many species utilize pheromone signaling as their primary form of communication, many also rely on visual signaling or some combination of these two modalities. In the sub-order Iguania, however, most species rely primarily on visual communication and have lost their ability to detect pheromones. *Anolis* lizards (anoles) comprise a large genus within this group that rely almost exclusively on visual communication cues. Anoles have a colorful skin flap on their neck called a dewlap that lizards unfurl repetitively in a stereotyped behavior for communication in mating and territorial interactions. The color of the dewlap is unique to many species and is hypothesized to be important primarily for species-specific communication in complex environments. Though the development of this species-specific coloration is not well understood, recent advancements in CRISPR/Cas technology have provided the opportunity to study the genetic underpinnings of reptilian skin pigmentation through genome manipulation. Here, we describe work investigating the role of Scavenger Receptor Class B Member 1 (*scarb1*) in skin color development of the brown anole, *Anolis sagrei*. *Scarb1* expression has been correlated with yellow coloration in anole skin and has been found to regulate the development of yellow pigment in other vertebrate species. We find that this gene is well conserved in ((*Anolis*)) and across vertebrates, and demonstrate success targeting *scarb1* with high efficiency guide RNAs. The end goal of this project is to utilize these CRISPR sgRNAs to create mutant individuals to further our understanding of the role of *scarb1* in color patterning in reptiles. We hypothesize that the disruption of *scarb1* will result in mutants lacking yellow pigment in the skin. These data will further our understanding of whether color patterning genes play a conserved role in development across tetrapod species, strengthening our understanding of color-based signaling and the development of these signals in an understudied phylum.

## **Human-Induced Changes in Atlantic Tropical Cyclones and the Bermuda High: Clues from the Last Millennium**

Emilia Pitchon | Mentor: Dr. Sylvia Dee

Current anthropogenic climate change is expected to increase hurricane intensity, with stronger winds, higher rainfall, and increased flooding, all of which pose a major threat to coastal communities. However, climate models vary in their predictions of how climate change will impact hurricane frequency and track, and 20th century data sources are limited given the brevity of the satellite era. To address this knowledge gap, we study the strength and position of the Bermuda High and how it has changed over the past millennium. The Bermuda High is a semipermanent high-pressure system over the Atlantic Ocean which impacts hurricane tracks and steering currents. To study the Bermuda High's behavior, we evaluate two climate products with sea level pressure data spanning 1000 to 2000 C.E.: the Last Millennium Reanalysis and the Community Earth System Model. We test the hypothesis that the Bermuda High shifts westward and

strengthens due to anthropogenic climate change, consistent with recent trends. We compare various Bermuda High indices (BHI) as defined by previous studies, representing different measures of position and strength of the high-pressure system. Maps of sea level pressure anomalies and hurricane tracks are generated during years with high vs. low BHI values. This allows us to better understand the relationship between the Bermuda High and hurricane characteristics over the last 1000 years, providing important context for the future. This work is critical to better constrain hurricane risks under anthropogenic climate change and may help protect the people and environments at risk.

## **Noninvasive Multiplexed Neuromodulation using Acoustically Targeted Chemogenetics**

Ryan Wang | Mentor: Dr. Jerzy Szablowski

Neuromodulation methods excite and inhibit neurons in a precise manner, providing possible treatments for atypical neuronal behavior and avenues for studying neural function. However, such methods can be invasive, thereby increasing the risks of surgical complications and tissue damage. Acoustically Targeted Chemogenetics (ATAC) is a noninvasive method for neuromodulation with high spatial, temporal, and cell-type specificity. ATAC uses focused ultrasound (FUS) to induce temporary blood-brain barrier opening (FUS-BBBO). Then, adeno-associated viruses (AAVs) carrying genes for Designer Receptors Exclusively Activated by Designer Drugs (DREADDs) can cross the blood-brain barrier and be delivered to cells in the targeted area. Neurons expressing these DREADDs are then activated (hM3dq receptor) or inhibited (hM4Di receptor) by a drug like the clozapine-n-oxide (CNO) metabolite clozapine. Recent research has introduced a new  $\kappa$ -opioid receptor DREADD (KORD) activated by a different drug, salvinorin B (SALB). With ATAC, it could be possible to noninvasively and independently modulate multiple areas of the brain by delivering genes for clozapine-activated DREADDs to one site, waiting for the BBB to close, then delivering genes for KORD to a second site. The two areas would then be modulated by clozapine and SALB independently. To first evaluate whether FUS-BBBO can deliver multiple genes, intersectional gene constructs were used; Cre recombinase (Cre), allows for the recombination of a "Floxed" construct. Co-delivery of the Cre enzyme and Floxed construct respectively resulted in  $\sim 50\%$  ( $\pm 7.39\%$ ) recombination efficiency at  $\sim 36\%$  ( $\pm 16.34\%$ ) transduction efficiency at the FUS focus versus 0% transduction in a contralateral control region ( $p < 0.05$ ;  $n = 5$ ). To assess whether two distinct FUS-BBBO sessions can be performed safely on the same subject, sessions delivering the intersectional gene constructs to overlapping areas were performed 3 days apart. These experiments showed similar recombination ( $\sim 35\% \pm 5.06\%$ ) and transduction efficiency ( $\sim 55\% \pm 12.24\%$ ) ( $p < 0.05$ ;  $n = 6$ ). These results suggest that multiplexed ATAC could be possible. Future work will evaluate optimal intervals between FUS-BBBO sessions and assess the effectiveness of multiplexed neuromodulation. Multiplexed ATAC could be applied to study multi-part neural circuits and treat multi-site diseases such as epilepsy and eating disorders.

## **Session II — Farnsworth Pavilion**

04/11/2023, 3:30pm—5:00pm

### **School of Humanities**

#### **History of Japanese Farmers in Texas**

Loic Duggal, Hoang Nguyen | Mentor: Dr. Sidney Lu

History of Japanese Farmers in Texas” is a digital humanities project that seeks to present the incredible yet lesser-known stories of Japanese immigrants in Texas. Using sources from the Houston Chapter of the Japanese American Citizens League, among others, we created an online exhibition under the Houston Asian American Archive to celebrate AAPI Heritage Month in May. The exhibition presents the stories of nearly twenty families and individual Japanese Texans, highlighting critical aspects of their life experiences including race, gender, agriculture, and community-building. Our project is an exercise in digital storytelling, through which we showcase how to organize and aggregate various sources to construct a central argument: that Japanese immigrants in Texas have shown admirable resilience and made great contributions to their communities.

#### **Providing Pain Management for Marginally Viable Neonates and Fetuses Does Not Make Abortion Ethically Impermissible**

Mabel Tang | Mentor: Dr. Frank Placencia

Neonatal pain management has long been controversial, and discourse surrounding fetal pain often translates into efforts to restrict abortion. In light of changing reproductive health policies, there are new implications regarding whether pain management should be extended to fetuses and a growing need for recommended courses of action in cases of uncertainty regarding pain management of marginally viable neonates. Some researchers make cases for not treating pain in mechanically ventilated neonates, even those considered marginally viable, given a lack of understanding of side effects and need of treatment, as well as improvements in pain symptoms. Additionally, anti-abortion proponents often cite evidence related to fetal pain to justify restrictive legislation. In contrast, I argue that pain management should be given to marginally viable neonates in cases of uncertainty in the efficacy and need of pain interventions, and that providing this care does not make abortion ethically impermissible. These arguments are grounded in a discussion of a fetus’s capacity to feel pain, clinicians’ obligations to a fetus and mother, and the virtues that should compel clinicians to treat pain.

## **Informing Trainings for the Harris County Domestic Violence Coordinating Council**

MaeLea Williams | Mentors: Dr. Brian Riedel and Dr. Helena Michie

After learning that Black women experience domestic violence at rates 2x higher than their white counterparts, I collaborated with the Harris County Domestic Violence Coordinating Council to conduct in-depth interviews with HCDVCC employees and grassroots advocates of domestic violence to answer the question: How can the HCDVCC better inform their trainings according to the needs of Black grassroots organizers who primarily serve Black and other women of color?

### School of Social Sciences

#### **Emotion Dysregulation Associated with Greater Depressive Symptoms and Memory for Details**

Jacob Buegler | Mentors: Dr. Stephanie Leal and Kayla Clark

Regulating our emotions is integral to our everyday experiences, and successful emotion regulation can impact our memory of emotional experiences. Individuals with depression show emotion dysregulation and impairments in memory. The hippocampus and amygdala are brain regions important for the emotional modulation of memory and are impacted in depression. As such, we aimed to examine the habitual use of emotion regulation strategies and emotion dysregulation in relation to memory performance and depressive symptoms. We measured lure discrimination index (LDI), a memory measure that relies on the hippocampus and highly detailed memory (Leal & Yassa, 2018). We found no significant relationship between habitual use of emotion regulation strategies and LDI. However, we found a significant relationship between higher depressive symptoms and better LDI that depended on greater emotion dysregulation. This suggests that individuals who are depressed and struggle with emotion dysregulation may focus on the unnecessary details of an experience. Forgetting details may function as a beneficial sorting mechanism which helps healthy people discard information that is not important to remember.

#### **The Effects of Attention and Learning on Episodic Memory Performance**

Aditi Velgekar (w/ Fernanda Morales-Calva and Michelle Sekili) | Mentor: Dr. Stephanie Leal

Episodic memory, the capacity to encode, store, and retrieve information about personal experiences, relies on the hippocampus and surrounding structures. Whether or not an element is remembered is reliant on many factors including attention and memorability. Memorability is the inherent characteristic of a stimulus to be better remembered than others. Learning, attention, and memory are clearly intertwined. Discerning the nature of their interactions can have strong implications for the classroom setting. Links between learning styles, attention and attention disorders, and memorability have not been established. We developed a task that taxes episodic memory to measure performance through target recognition and lure discrimination. The former denotes one's ability to

recognize a previously seen image while the latter denotes one's ability to distinguish between two similar images. We aimed to see the interactions between memory performance on a memorability-based task and potential correlations with attention measures and learning style preferences. Determining relationships that exist could elucidate potential improvements applicable to classrooms and curriculums.

## School of Architecture

### **Present Future**

Isabella de la Iglesia, Bay Fujimoto | Mentor: Dr. Albert Pope

Our project proposes a method of integrating the natural landscape of Clear Creek bayou into the urban fabric of the Greater Hobby Superneighborhood using an algorithmic method of form generation. The Searchspace is a set of rules and operations that were used to create shapes that create different external and internal relations. Forms that were generated from this Searchspace were organized into bands and categorized as being permeable, semi-permeable, or impermeable to indicate porosity. These qualities were then developed to create spaces of community and interaction that were not possible within the suburban sprawl found in the existing condition. Trees and prairie grasses were also composed to create borders, fields, and transitional moments within the housing. The grid structure of the existing residential neighborhood is used to structure the new housing subdivisions, and the project consists of bands of housing that lie in between a large coastal prairie landscape and two wooded forests, allowing for nature to develop and diversify naturally. The project transforms a sparse suburban neighborhood into a fully integrated community that extends the bayou's abundance of natural resources into south Greater Hobby.

# RURS Schedule Information

## **Poster Sessions:**

RMC Grand Hall

Poster Session I: 11:00 am - 12:00 pm

Poster Session II: 12:45 pm - 1:45 pm

Poster Session III: 2:30 - 3:30 pm

## **Oral Sessions:**

RMC Farnsworth Pavilion

Oral Session I: 10:00 am - 10:40 am

Oral Session II: 11:00 am - 12:30 pm

Oral Session III: 1:30 - 3:30 pm

## **Closing Celebration and Awards:**

RMC Farnsworth Pavilion and Brown Garden

4:30 - 6:00 pm

Food trucks, ice cream, cotton candy, free professional photographs, and award announcements!

*In the case of inclement weather, the Closing Ceremony will be located in the RMC Grand Hall.*

# Engineering Poster Presentations

## **Finetuning Models of Code with Compiler Feedback**

Chima Adiole | Mentor: Christopher Jermaine

Transformer-based language models such as GPT2 have been utilized as the backbone of models for code generation with promising results. However, the challenge with using these language models lies in the fundamental difference between code and natural language. To address this limitation, we propose a pre-training approach using compiler feedback via static-analysis to improve code generation capabilities of language models. This ensures that properties that characterize functional code, such as syntax and semantics, are captured by the model. We model this feedback approach as a markov decision process where the model parameters correspond to the stochastic policy, the token generation per time step corresponds to the action, and the compiler serves as the environment for the training. In addition to the compiler feedback mechanism, we utilize a discriminator network to ensure that the code generated by our model not only passes static-analysis checks but is also functional. Our method can be applied directly to a transformer-based language model or combined with reinforcement learning-based finetuning approaches, such as CodeRL, to achieve new SOTA results for program synthesis.

## **Multifaceted Approach Towards Elucidating the Chaperone Pathway of the *Bacillus megaterium* Gas Vesicle Shell Protein**

Erica Anton | Mentor: Andrew Anderson

Gas vesicles (GVs) are gas-filled protein nanostructures that provide buoyancy to photosynthetic microbes. GV's have recently become an area of interest due to their applications in high-resolution imaging and biomanufacturing. However, much is still unknown regarding the function, stoichiometry, and organization of GV proteins (Gvps). Our previous research on the assembly of GV's in the *B. megaterium* GV operon suggests possible chaperoning mechanisms in gvpF and gvpG on the major shell protein gvpB. Thus, we focus on expounding upon the gvpG-gvpB interaction to determine which elements of gvpB are forming an interface with gvpG and being chaperoned. Analyses of domain deletions on gvpB and their effect on gvpG-gvpB interaction revealed site-dependent interactions that corresponded with previously-done structural simulations. This protein interaction analysis provided us with a better understanding of the process of gas vesicle formation and growth, as well as validated a series of experiments useful in probing for chaperoning.

## **Sensor Placement for Learning Network Flows**

Arnav Burudgunte | Mentor: Silva Arlei

Large infrastructure networks (e.g., for transportation and power distribution) require constant monitoring for failures, congestion, and other adversarial events. However, assigning a sensor to every link in the network is often infeasible due to placement and maintenance costs. Instead, sensors can be placed only on a few key links and machine learning algorithms can be leverage for the inference of missing measurements (e.g.



vehicle speeds, power flows) across the network. In this project, we investigate the sensor placement problem for network flows from a computational lens. We first formalize the problem and show that it is NP-hard to optimally place a fixed set of sensors. Next, we propose efficient and adaptive greedy heuristics for sensor placement that scale to large networks. Our experiments, using datasets from multiple application domains, show that the proposed approaches enable more accurate flow inference than existing alternatives from the research literature, which has potential implications for existing networked infrastructure systems.

### **System for Situational Awareness in High Risk Environments**

Maria Bustillo, Anyssa Castorina, Clayton Ramsey | Mentor: Gary Woods  
Military personnel, emergency responders, construction workers, and others who find themselves in dangerous situations must complete high-risk tasks while simultaneously processing vast quantities of information. We present a heads-up display helmet with integrated sensors that take in visual and audio information, processes it, and presents it to users in a non-distracting manner to improve their situational awareness. Our device has two separate subsystems for processing audio and visual data. The audio subsystem utilizes a microphone array, a microcomputer, and haptic motors to localize loud audio impulses. This subsystem localizes audio impulses with an error of  $-1.97^\circ \pm 26.56^\circ$ . The visual subsystem analyzes video data from a backward-facing stereo camera to detect people and motion behind a user. This data is presented in a heads-up display to the user via a compact, radar-like screen. Future directions of this project include integration of additional sensors, reduction in form factor, and refinement of existing subsystems.

### ***StimuSock*, a Wearable Device for Managing Diabetic Neuropathy Symptoms in the Foot**

Abby Dowse, Yannie Guo, Andrei Mitrofan, Sarah Park , Kelly Xu | Mentor:  
Gururaj Naik

Diabetes affects around 86 million people in the US alone, and up to 50% of those people will develop some form of neuropathy in their lifetime. This can result in nerve damage in various parts of the body, with one of the most common areas being the weight-bearing areas of their feet. Loss of sensation in the feet results in abnormal gait and balance, which increases risk of injury. In addition, neuropathic pain prevents users from engaging in their everyday activities as they normally would. Our team has set about designing such a device by employing two main technologies: transcutaneous electrical nerve stimulation (TENS) and vibrational haptics therapy. The TENS component is intended to provide relief to the neuropathic pain caused by nerve damage using electrical signals that interfere with pain signals that travel from the foot to the brain. The vibrational haptics component is intended to improve gait and balance by providing the user with increased sensory awareness of their feet. Our goal is to integrate these two components into one wearable device that will comfortably allow patients to receive on-the-go pain relief at the push of a button.

## **SpeakEasy**

Christian Durante, Fadil Eledath, Paul Kim, Jordan Ngo, Kevin Yin | Mentor:  
Sabia Abidi

Military personnel must be able to communicate effectively in all situations for maximal efficiency. However, certain situational factors such as high noise levels, blocked sight lines, and the need to remain undetected render conventional verbal and visual communications unusable in certain operations. Furthermore, no solutions exist for this communication problem that allows the users to avoid detection and reliably communicate with each other. Consequently, this project will create a durable device that allows for expansive and intuitive nonverbal and nonvisual real-time communication of crucial information. For usability, it should be small, lightweight, and power-efficient. It must also be able to penetrate obstacles and be able to transmit messages between multiple (3+) users.

## **Evaluation of Imitation Learning Algorithms on Robotic Tasks**

Joseph Gioia | Mentor: Unhelkar Vaibhav

Over 2.5 million industrial robots operate in factories around the world. However, most of these robots execute predetermined paths, relying on expert engineers to program every additional task. To simplify the process of programming robot tasks, there is an increasing interest in the use of machine learning to mimic a human expert's behavior. This field of research is known as imitation learning. A key limitation of many imitation learning papers is their reliance on a small number of simulated environments to demonstrate their results. To accelerate the development and evaluation of imitation learning, we have developed a software stack to evaluate the efficacy of imitation learning algorithms on a real-world robot. Our software implements physical counterparts to common simulated tasks and techniques for gathering expert demonstrations. In addition, we have integrations for object tracking technology, such as the OptiTrack motion capture system and the Realsense depth camera. In our testing thus far, we have identified a key need for imitation learning algorithms that better accommodate tasks where the expert's demonstrations and robot's environments are not fully observable.

## **Building Capacities for Systematic and Qualitative Analysis in the Social Media Archive**

Sejal Gupta | Mentor: César Uribe

Through analyzing the Goya Boycott, a global digital discourse about the Goya Foods CEO's support of Donald Trump, we aim to create systematic methods for the quantitative and qualitative analysis of Twitter data to support humanities research. These tools automate common research practices for an efficient, meaningful study of large datasets. With Twitter's Developer API, natural language processing libraries, and geographic tools, we have scraped and analyzed 60k+ tweets. Specifically, we examined sentiment around actors/subtopics in the discourse and designed interactive maps visualizing global spread over time. We derive broad conclusions about our user population by filtering tweets to understand how individuals engage in trending topics. This study applies to the larger humanities-based social media analysis of cultural movements. Our analysis highlights how users connect their racial/ethnic identity directly to their relationship to

Goya Foods and demand accountability from corporations. Ultimately, this project intends to assist researchers to quickly evaluate Twitter data and develop a comprehensive understanding of the social media discourse around a specified topic.

### **Examining EHD1 Interaction with Big Tau**

Alexander Han | Mentor: Huda Zoghbi

Tau is a neuronal protein involved in stabilizing microtubules, and its abnormal hyperphosphorylation and aggregation are hallmarks of Alzheimer's disease. We recently discovered that big tau, an understudied tau isoform, is highly expressed in the cerebellum, a region typically spared from Alzheimer disease (AD) tau pathology. We suspect that function of big tau differs from other tau isoforms due to its unique N-terminal region. To this end, we carried out immunoprecipitation-Mass Spectrometry (IP-MS) to identify the interactomes of big tau and the typical tau isoforms. We discovered EHD1 as an interactor that preferentially binds big tau. EHD1 is a membrane-binding protein involved in intracellular transport and primary cilium assembly, and it plays an important role in AD-related beta-secretase and A $\beta$  generation. The project aims to (1) further validate the interaction between EHD1 and big tau and (2) identify the domain of big tau that interacts with EHD1 using co-immunoprecipitation (Co-IP) methods. The findings from this project will improve our understanding of the functional role of big tau and its relationship with EHD1.

### **Mechanical Engineering Senior Design: Project Dynamometer**

Andrew Hooke, Ryan Ky, Ruben Marroquin, Saswat Pati, Mark Schara, Gerdardo Vega | Mentor: Gary Woods

The purpose of Project DYNAMOMETER was to develop one to two bespoke dynamometers for Rice Electric Vehicle's (REV) competition car. This dyno needed to be cost effective, compact, and specifically tailored to REV's needs. While commercially available dynos are sold on the market, their size and cost limit REV's ability to use them and so our team was brought in to develop a custom dyno. This dyno accurately measures the competition car's RPM and torque and through our fabrication process, our Dyno is safe, compact, cost-effective, and able to fulfill REV's needs for their competition car.

### **A Gromov-Wasserstein Approach for African Food Web Network Analysis**

Kai Hung | Mentor: César Uribe

The prey-predator interactions of food web networks comprise a critical role in maintaining biodiversity, which is central to sustaining human well-being. As projected human population growth for Sub-Saharan Africa ranks among the world's highest, understanding mammal food webs is crucial to inform ecological preservation efforts. However, modern graph analysis methods are either computationally intractable, analyze network dynamics in isolation, or sacrifice interpretability for predictive power. Furthermore, to the best of our knowledge, there are no well-studied frameworks tailored to computing dissimilarity between directed networks of different sizes. We propose an optimal transport-based topological data analysis paradigm. Specifically, we leverage the Gromov-Wasserstein Distance, which provides a permutation-invariant metric between networks of varying sizes. Our preliminary results show statistically significant

correlation between food web dissimilarity with primal productivity and fragmentation. With this framework, we aim to provide a provably correct and flexible data-driven toolkit for ecologists to predict the consequences of conservation decisions on a community.

### **Topic Database Creation over the Rice Thresher**

Zoe Katz | Mentor: Edgar Avalos Guana

Large text corpora are useful to analyze trends over variables like time and location. In data analysis and machine learning, fields like social media analysis, market research, and text mining make use of unstructured data. In this project, we created a large database of text from editions of the Thresher, Rice University's student-run newspaper. The Thresher has been in publication since 1916, and continues publishing to this day. Using Rice's digital scholarship archive, PDFs of each Thresher were fetched and stored to later extract text. Due to some blurry and pixelated portions, as well as an absence of column consistency in earlier editions, a non-traditional approach was used to extract the text from the documents. The PDFs were converted to images and optical character recognition (OCR) was performed, resulting in a large textual database. Some post-processing was done on the extracted text to fix issues like misspellings. Through the use of topic vectors and sentiment analysis, this database can aid in future analysis regarding the evolution of key events and ideas during the past 100 years and how they relate to Rice University, the Houston area, and the U.S. as a whole.

### **Modeling Surgical Effects on Exercise Tolerance in Fontan Patients**

Chawit Kritpracha | Mentor: Beatrice Riviere

The Fontan physiology is a common surgically created circulation for patients with a single functioning ventricle. Patients with this physiology tend to have lower exercise capacity compared to those with a normal circulation. Although much experimental work has been done to investigate this reduction in exercise capacity, there are few systematic modeling studies for this problem. We propose a mathematical model to describe the Fontan physiology under exercise. Furthermore, we propose a heuristic to estimate exercise capacity. The model is used to separately investigate the effect of three surgically determined parameters on exercise capacity, namely the arterial compliance, the systemic-venous to pulmonary-venous fenestration, and the resistance of the total cavopulmonary connection.

### **Enhancement Cavity Design for P-MOKE**

Edwin J. Lebrón Pérez | Mentor: Hanyu Zhu

The polar magneto-optic Kerr effect (P-MOKE) describes the polarization changes to light reflected from a surface whose magnetic vector is perpendicular to the reflection surface. The difference in rotation of the light is also known as the Kerr angle. This physical phenomenon is important since it can allow us to measure the magnetization of a thin film material without damaging the original sample and has a myriad of real-world applications. However, measuring the Kerr angle can be difficult, given that it generally has a very subtle effect on the order of microradians and is prone to noise in the system. This research poster proposes a photonic cavity approach to enhance the P-MOKE effect signal by depositing an anti-reflectance coating on our material of interest. The ideal

thickness of this layer is calculated by a simple 5-layer model based on the transfer matrix method. In our simulation, the observed enhancement has been up to two orders of magnitude, which could be verified in later experiments.

## **Promoting Academic Success: The Influence of Demographics, Family, and County Diversity on Educational Outcomes in 12th Graders**

Tina Li | Mentor: Catherine Barber

This study examines demographic and family variables as predictors of student academic outcomes and the relationship between county-level school demographic diversity and graduation rates, using a correlational research design with data from the 2019 Parent and Family Involvement in Education Survey, the 2018-2019 Common Core of Data, and the 2019 Texas Education Agency Four-Year Graduation and Dropout Data. Family variables include parent educational attainment and language spoken at home, while demographic variables include the student's race/ethnicity and sex. Preliminary analysis demonstrated that having English-speaking parents with higher educational attainment is associated with more favorable educational outcomes. Investigation of county-level school demographic diversity is still in the exploratory phase at the time of abstract submission, but it is hypothesized that diversity will be positively correlated with graduation rates. Findings from this study can provide important insights into the complex interplay between these factors and contribute to the development of interventions and policies to promote academic success for all students.

## **Harnessing Intrinsically Disordered Regions (IDRs) of NUP98 for Precise Transcriptional Control through Phase Separation**

Jennifer Liu | Mentor: Isaac Hilton

Internally disordered regions (IDRs) are known to drive liquid-liquid phase separation and subsequently upregulate gene expression. The phenylalanine-glycine (FG) rich IDR at the N-terminal of the nucleoporin protein NUP98 is of particular interest because this site often participates in chromosomal translocations associated with various types of leukemias. Previous work has established the ability of NUP98 N-terminal to phase separate and drive loci-specific gene activation when fused to the CRISPR/dCas9 system. However, the mechanism of this phase separation and the ability to activate gene expression is poorly understood. In this study, we show that the higher number of FG repeats in the NUP98 IDR leads to more pronounced phase separation and, as a result, higher transcriptional activation. We further harness the ability of NUP98 to generate phase separation by generating different variants of the IDR and fusing them to the CRISPR/dCas9 system to precisely target and regulate gene expression at specific loci. This new synthetic biology tool enables versatile yet precise manipulations of the genome and epigenome with substantial therapeutic potential.

## **Designing Synthetic Phosphorylation Circuits for Rapid, Reversible, and Customized Sense-and-Response in Mammalian Cells**

Jing Liu | Mentor: Caleb Bashor

Synthetic circuits offer precise spatial and temporal control for cells to sense, process, and respond to environmental stimuli. However, common mechanisms, such as using proteolytic activity or transcription regulation, suffer from 1) slow regulation and 2) irreversible signal transduction, limiting their ease of manipulation. We developed a synthetic circuit that enhances both aspects. We chose phosphorylation as the main mechanism of signal transduction, allowing fast signaling and regulation by bypassing transcription and translation. To enable reversibility, we used a push-pull motif involving kinase and phosphatase that can modify and un-modify a target protein substrate. The push-pull network can be tuned by adjusting interaction affinity, kinase expression, and kinase activity. By connecting various sensing modules and transcriptional outputs to the push-pull network, the circuit further allows cells to detect specific extracellular signals and have customized output such as a change in gene expression. This network enables rapid, reversible, and customized sense-and-response behaviors of mammalian cells, with great potential to develop patient-defined cell-based therapies.

## **3D Fabricated Ocular Drug Delivery Wafer Therapeutic**

Shreya Majeti | Mentor: Ghanashyam Acharya

Eye injuries cause corneal scarring and vision loss. While beneficial for avoiding invasive and scarce corneal transplants, eye drops lack longevity since innate ocular protective measures initiate reflexive tearing, blinking, and nasolacrimal drainage which clear foreign substances. The remaining drug particles are systemically absorbed through blood capillaries in the conjunctival sac which further decreases absorption. To combat transient relief, eye drops are administered at increased frequency which proves inconvenient and inefficient over time. There is also exacerbated risk for side effects with repeated reapplication such as inflammation, discomfort, all of which contribute to poor patient compliance. Emulsions, liposomes, micelles, nanoparticle suspensions, in situ gel-forming systems, and drug loaded contacts have been introduced for ocular drug delivery but were proven comparable to eye drops in efficacy/bioavailability. As such, we propose drug loaded wafers to restore normal physiological functions of the eye after considering patient effort, ocular retention, and overall potency.

## **Thermal Stability of Aligned Carbon Nanotubes in Ambient Air**

Chacko Mathai | Mentor: Gururaj Naik

Aligned CNT films have potential as a refractory material for thermal emitters due to their hyperbolic dispersion. With extreme anisotropy and large photonic density of states, CNTs are promising in energy applications such as thermophotovoltaic emitters. However, their stability under harsh environments remains unexplored. We study how the optical properties of aligned CNTs evolve through annealing in ambient air. Further, we show that coating with a thin layer (<100 nm) of dielectric dramatically increases their thermal stability, making them promising for thermal radiation applications. CNT samples were annealed in a tube furnace in ambient air at 400 degrees Celsius for one-hour periods, and an FTIR spectrometer was used to measure the IR reflectance in TE

configuration with polarization parallel and perpendicular to the tubes. The annealing degrades their optical properties in reducing the plasma frequency and drastically increasing Drude damping. However, the coated films showed negligible change in their reflectance spectra. Coating aligned CNT films is a promising approach to extending their thermal stability and preserving their broadband hyperbolic dispersion.

## **Genetic Perturbation Through Prime Editing**

Advaith Peddi | Mentor: Qichen Yuan

Gene editing is a field that has seen rapid development in the past decade with the CRISPR-Cas system. However, CRISPR-Cas nuclease is not without its flaws; it causes double strand breaks that can result in mutations and has a not insignificant rate of bystander mutations. The prime editor is a modified version of the CRISPR-Cas9 system that addresses these concerns. The purpose of this study is to enable a prime editor with the ability to perform all types of genetic perturbations to study and treat disease models. Various cell culture, DNA modification, DNA assembly, and DNA analysis protocols were performed. Through these protocols, the most ideal truncated guide RNA for activation and best PE (prime editor) system for editing efficacy were found. The best truncated guide RNA is 11 base pairs for RHOXF2 and 19 base pairs for IL1B, while the best PE system for both the H1060Q and R778L edits is the PE3 with an epegRNA. With this information, we can proceed to combine the activating and editing functions of the prime editor into one DAP (drive-and-process) array for future experimentation.

## **Fabrication of Novel Small-Diameter Thromboresistant Vascular Grafts**

Suran Somawardana | Mentor: Ghanashyam Acharya

Vascular diseases are the leading cause of mortality worldwide. Symptomatic vascular disease involving vessels that are smaller than 6mm internal diameter constitutes the majority of vascular disease cases. In the majority of cases, the only correction for this condition is vascular reconstruction, or bypass surgery with autologous or synthetic vascular grafts. However, 20-40% of these procedures fail within a year due to acute thrombosis, early occlusion, or neointimal hyperplasia. The availability of small-diameter, thromboresistant artificial grafts would greatly increase the number of patients that could be treated and reduce the number of complications post-surgery. In this project, 2mm internal diameter thromboresistant vascular grafts were synthesized. Using electrospinning techniques, these vascular grafts gain surface charges that can be adjusted to match those in the endothelial lumen. Mechanical properties such as tensile strength, suture retention, and burst pressure will be tested. Zeta potential analysis will determine the optimal contact angle and how it affects thrombus creation. Lastly, cell biocompatibility will be investigated to determine long-term success.

## **In Vitro Investigation of the Effect of UV-Crosslinked Demineralized Bone Matrix Nanoparticles on Inducing Osteogenesis on 3D Printed Bioscaffolds**

Reyhan Umurhan | Mentor: Antonios Mikos

Bone regeneration studies have been investigating the implantation of 3D scaffolds made from extracellular matrices to better understand the regulatory role and function of these

biomaterials in inducing osteogenic potential. In this study, a 21-day *in vitro* investigation of human mesenchymal cells seeded on UV-crosslinked 3D printed scaffolds of bioinks made by combining varying ratios of methacryloylated demineralized bone matrix (DBM) and gelatin nanoparticles under basal and osteogenic media types was conducted. Mechanical stability and physicochemical properties of the scaffolds were analyzed under degradation and swelling studies. Osteogenic properties related to bone formation were investigated via quantitative determination of the intracellular levels of Alkaline Phosphatase enzyme and dsDNA, as well as expression of RUNX2 and OCN genes. Results have shown increased cell proliferation in higher DBM groups, although some variability with ALP enzyme was observed. Future directions can focus on analyzing osteogenic differentiation patterns under *in vivo* studies. Clinical applications of DBM-based hydrogels can be consequential in biomaterial-based tissue engineering.

### **Evaluating the Effects of Low-Temperature Perovskite Ink Storage on Solution Degradation, Film Quality, and Solar Cell Device Performance**

Clara Ursic | Mentor: Aditya Mohite

Thin-film halide perovskite solar cells have exceeded silicon photovoltaics in power conversion efficiency, yet they lack scalable manufacturing techniques. Scalable solution-based manufacturing via spin coating or screen printing would require thousands of liters of perovskite precursor inks per day, so storage of such inks is a necessity. Here we investigated the degradation of MAPbI<sub>3</sub> perovskite inks and whether storage at near 0C temperatures preserves them. We saw a decrease in the intensities of PL and XRD peaks of films fabricated from inks aged at room temperature, which indicates decreased crystallinity and film quality compared to the unaged control films. XRD peaks also shifted to lower angles compared to the control films, indicating an expansion of the crystal lattice, which lowers hole mobility and, thus, decreases device efficiency. However, films fabricated from inks aged at 4C retained nearly identical peak intensities and XRD angles as the control films, demonstrating that low-temperature storage does inhibit ink degradation. More research is needed to understand solution chemistry, the origin of lattice expansion, and efficiencies of devices made from these films.

### **Computational Analysis of Molecular Overlap of Mutations in B-Cell Lymphoma**

Samhita Vinay | Mentor: Holly Hill

B-cell lymphomas are a common type of cancer with heterogeneous disease subtypes and forms of molecular pathogenesis. However, among subtypes, some overlap in potentially targetable somatic mutations exists. To assess this hypothesis, we curated primary tumor mutational data from B-cell lymphoma patients (n = 2352) found in the AACR Project Genie cancer dataset. Data preprocessing involved generating dummy variables for each mutation and removing low variance genes. The most common subtypes: Diffuse Large B-Cell Lymphoma (DLBCL) (n = 541), Follicular Lymphoma (FL) (n = 454), and Mantle Cell Lymphoma (MCL) (n = 259) and chromatin-modifying mutations ((KMT2D)) and ((EZH2)) were utilized for preliminary analysis, which suggested overlap between MCL and DLBCL patients for ((KMT2D)), and between FL and DLBCL patients for ((EZH2)). Further analysis will consist of developing a hierarchical clustering algorithm to



understand overlapping molecular profiles in patients across all subtypes integrating over 100 mutations. Understanding overlapping molecular profiles of B-cell malignancy subtypes may allow for grouping of patients for precision medicine trials.

## **Sheet-Based Fluidic Diodes for Integrated Circuitry in Soft Robots**

Vi Vo | Mentor: Daniel Preston

Pneumatically driven soft robots achieve complex motions including bending, elongation, and stretching by expansion of embedded internal channels. However, deployment of these robots remains a challenge due to their reliance on rigid and bulky electronic controllers and solenoid valves. This infrastructure compromises the conformability, adaptivity, and mobility of soft robots. Recent research in soft robotics has attempted to address this limitation by developing novel fluidic components that can eliminate the need for rigid controllers and valves. Here, we expand on this work by creating soft fluidic diodes (i.e., devices that enforce flow in a single direction), leveraging the material compliance of two-dimensional sheet materials and the geometric design of flow channels forming the inflated internal volume when actuated to mechanically prohibit backflow. We demonstrate the ability of these fluidic diodes to respond effectively to fluidic signals, exemplified through operations analogous to electric circuits including diode logic gates and bridge rectification. We expect this work will give rise to new approaches in onboard control schemes of soft robotic systems.

## **Large-scale synthesis of Degradable Bottlebrush Polymers through Reversible Disulfide Linkages**

Hanqing Wang | Mentor: Dongjoo Lee

Bottlebrush polymers have densely grafted side-chains attached to a linear backbone, and the highly branched architecture leads to unique properties such as a very high entanglement molecular weight, rapid kinetics for self-assembly, and high elasticity. As a result, bottlebrush polymers have versatile applications such as super soft elastomer, photonic crystal, and drug delivery. However, the development and commercialization of bottlebrush polymers are challenged by complex synthetic methods, high cost of reagents, low product yields, and limited degradability. Herein, we introduce a novel approach that enables the simple, large-scale, and inexpensive synthesis of degradable bottlebrush polymers under mild conditions using  $\alpha$ -lipoic acid (LA). Under ultraviolet light (365 nm) without any catalyst and at ambient temperature, the LA functional group undergoes a “grafting-through” ring-opening polymerization (ROP) to produce bottlebrush polymer with various side-chain chemistries. Due to the dynamic nature of the disulfide bond, LA-functionalized bottlebrush polymer can be depolymerized into macromonomers, and those macromonomers can be repolymerized back into bottlebrush polymer.

## **Systematic Protein-Protein Interaction Analysis and Multi-Inducer Genetic Circuits Elucidate Assembly of Gas Vesicles**

Vivian Wong | Mentor: George Lu

Gas vesicles (GVs) are gas-filled protein nanostructures that naturally evolved in photosynthetic microbes to provide buoyancy, allowing for exciting engineering potential as contrast agent imaging, biomaterials, and more. However, a challenge of GV research

to overcome is the slow growth rates and genetic intractability of native species and our limited understanding of the assembly process. Here, we discuss two systematic approaches that work hand-in-hand to elucidate the molecular mechanisms of gas vesicle proteins (gvp's) underlying GV assembly *in vivo*. First, we devised a modular assay based on split-luciferase complementation to screen the interactions of 11 gvp's in the *B. megaterium* GV operon. Our analysis revealed a dense interaction network of gvp's that is dynamic throughout assembly. Second, we built a series of genetic circuits for the *Anabaena flos-aquae* operon to investigate optimal gvp stoichiometry. The design allows each gvp to be individually modulated by a small-molecule inducer to tune expression. This ongoing work will ultimately lead to a new generation of non-native host cells that better express GVs for immediate biotechnology applications.

# Humanities Poster Presentations

## **The Use of Logic Models in Evaluating Health Professions Education Programs with the Goal of Innovating and Improving Healthcare**

Morikeoluwa Ayodeji | Mentor: Travis Croom

Health Professions Education (HPE) is the field pertaining to the training and education of all professions within the healthcare spectrum. This includes not only the process by which health professionals are trained but also how those individuals who train health professionals are trained to train. Programs seeking to establish leaders in the field of HPE utilize competency-based curricula and activities to develop desired learning outcomes and impact for their trainees. To ensure that learners are leaving with the necessary skills and proficiencies, the effectiveness of HPE programs must be assessed and evaluated. A program logic model was developed for the Health Professions Education Evaluation and Research (HPEER) post-graduate fellowship to serve as the evaluation bedrock of the program. The multi-step development of the model served to maximize its comprehensiveness and accuracy, assist in evaluating and improving the HPEER fellowship, and thus innovate healthcare. This logic model facilitates reflection on the purpose of the program's activities, assists in identifying specific areas for improvement, and provides a common framework for stakeholders and the public.

## **Investigating the Stigmas of Obstetric Science: Representations of Motherhood and Surrogacy**

Ellie Cha | Mentor: Amanda Johnson

This paper examines the stigmas of obstetric science and gestational surrogacy in the United States. Through the analysis of different literary mediums and films, it is evident that there is a critique of women in the gestational surrogacy industry. This paper focuses on researching which narratives promulgate the idea of a "bad" surrogate or mother in modern society. Factors of age, education, socio-economic class, and normative values of motherhood come into play when investigating why certain modes of motherhood are acceptable while others are not. Scholastic journals, fiction & nonfiction books, and contemporary films on surrogacy were analyzed to examine how surrogacy processes and public perception have changed over time. This paper also aims to uncover the mystics of obstetric science in mainstream media portrayals of exploited or exploitative women - particularly those involving power differentials of informed consent.

## **Beyond the 1915 *Red Book of Houston*: The Expanded Biographies of Houston's Black Life in the Early Twentieth Century**

Celeste Colato | Mentor: Fay Yarbrough

The *1915 Red Book*, filled with biographies and photographs taken in 1915, provides a glimpse into the lives of Black middle-upper-class Houstonians. This one-time published book offers a snapshot of the lives of successful Black Citizens. Through my research, I expand on the given information by creating more extensive biographies of the people

inside the book beyond 1915, filling in the gaps as we go. This project builds on previous undergraduate research conducted with the Red Book, which mapped the addresses of businesses within the text using geospatial mapping data. By collecting and analyzing records ranging from birth certificates, African-American and Houston newspapers, city directories, census data, and many other databases, the lives of those in the 1915 Red Book expand beyond the page. Using the data to track how families grew, businesses changed and people moved out of Houston as direct reflections of their time's social, economic, and political changes. The project aspires to track the lives of those in the Red Book beyond what is known and truly grasp their lasting impact as an essential part of Houston's history.

### **The Quality of Quality Improvement: An Analysis of Alumni Outcomes in the VA Quality Scholars Fellowship**

Angela (Angie) Fan | Mentor: Beverly Mitchell

The VA Quality Scholars (VAQS) Fellowship is the premier training program in quality improvement (QI) and patient safety at the VA. QI skills have become increasingly pertinent for leaders in healthcare, resulting in an increase of training programs. However, the field lacks data regarding alumni outcomes in these programs. Similar to other educational institutions and fellowships, tracking VAQS alumni career trajectories fosters continuous program improvement and a network of collaboration. Using data from the VAQS 2021 Alumni survey, this project studies the outcomes of VAQS alumni, focusing on career trajectory, VA retention, and application of QI skills. An alumni survey was developed and administered to 300+ VAQS alumni. We used REDCap and Atlas.ti to conduct quantitative and qualitative analysis. Out of 101 responses, 70 alums submitted their CVs for further qualitative analysis. Initial findings indicate alumni are commonly in leadership positions, direct quality improvement projects, and remain affiliated with the VA. These findings contribute to VAQS' national curriculum, influence the direction of other VA fellowships, and address gaps in alumni outcomes.

### **Choreographing Slave Revolt: Maroon Involvement in the 1776 Hanover Parish Conspiracy**

Joseph Flores | Mentor: James Sidbury

Enslaved Black people plotted to kill white Jamaicans in Hanover Parish in July 1776. White Jamaicans uncovered a conspiracy involving multiple estates and, in response, executed 17 enslaved people, punished 11 severely, and had 45 deported. Two enslaved men testified that the Trelawny Town Maroons promised to join the revolt because white Jamaicans had begun to employ Rangers to catch runaway slaves. The Maroons, descendants of former slaves left behind by the Spanish, grew over time with the arrival of runaways. White Jamaicans granted Maroons relative autonomy in exchange for catching runaways and performing other tasks. This essay suggests that the Maroons instigated a rebellion among the enslaved with the idea that they would kill the enslaved insurrectionists. The Maroons probably would not have helped the rebels because a failed attack would have threatened the freedoms they had previously won. The Maroons sought to recapture the bargaining power they earned after putting down a slave revolt that engulfed Jamaica from 1760-1761. Studying their involvement in this conspiracy is

essential to understanding relations among enslaved Black people, Maroons, and white Jamaicans.

## **Inheritance and Revolt: Aphra Behn's Poetic Exploration of Libertinism**

Dian "Tiffany" Jin | Mentor: Emily Houlik-Ritchey

My research project explores Aphra Behn's poems as both inheritance and revolt of the libertine tradition in the Restoration Era. Employing libertine tropes allows Behn to join the inner circle of male poets, such as the Earl of Rochester. However, rather than endorsing the male-dominated rakish lifestyle, I argue that Behn strategically incorporates her feminist critique in her poems to expose and subvert its androcentric nature. While libertinism based itself on epicurean philosophy and its contemporary political theories that centered on liberating the pursuit of human desires, Behn's poems uncover that under patriarchy, the enjoyment of one's sexual desires is only a male privilege. My project close reads and analyzes Behn's poems by surveying the different gendered perspectives, the parody effect of reversed gender expectations, her critique on androcentric belligerent metaphors that sabotages romantic relationships, and alternative female erotic relationships. Ultimately, my project aims to show how Behn's non-hegemonic social position allows her to write in the hegemonic cultural space with a double vision that seeks to expose the hypocrisy within androcentric traditions.

## **"I Want to Believe": Conspiracy Theories as Conservative Melancholia in *The X-Files***

Kyra McKauffley | Mentor: Travis Alexander

Sigmund Freud's theory of melancholia describes the process by which a person represses the loss of something beloved. This presentation argues that the television series *The X-Files* presents conspiracy theories as a mechanism of melancholia. Firstly, it establishes this link through the character Fox Mulder, who investigates conspiracy theories as a means of repressing the loss of his sister. However, conspiracy theories facilitate melancholia beyond this individual scale. *The X-Files* illustrates how conspiracy theories of the 1990s repress American conservatives' loss of the Soviet Union following the end of the Cold War. By re-creating the Soviet Union, these theories provide conservatives with an opposing force for them to define themselves in opposition to. Thus, *The X-Files* illuminates the historical trend of conspiracy theories as a mechanism of conservative melancholia that continues into the present day.

## **An Analysis of Clinton Administration through the lens of Memoranda for President on Science & Technology**

Yufei Qi | Mentor: Kenneth Evans

After the dissolution of the Soviet Union in 1991, the United States lost its biggest geopolitical rival, and its primary motivator for investing in defense technology. During the Clinton administration, research and development funding supported increased work in information technology, biomedicine, climate science, and other non-defense science programs. Congressional appropriations for different scientific fields are one measure of the United States' overall research and development priorities. However, congressional appropriations are often a compromise between the executive and legislative branches.

Understanding the science and technology policy agenda of the White House alone is challenging due to the lack of clear metrics. This poster presents an analysis of 119 memoranda to President Clinton on science and technology produced by the president's science advisor Dr. Neal Lane, from January 1998 through December 2000. Statistics on the frequency and position of topics in the weekly memoranda were collected to assess the Clinton administration's science & technology policy priorities and how and when those issues were presented directly to the president.

# Natural Sciences

## Poster Presentations

### **Applying Electron Cryo-Tomography to Identify Structural Abnormalities in Platelets with Acute Myeloid Leukemia**

Anisha Abraham, Ethan Boniuk | Mentor: Zhao Wang

Acute myeloid leukemia (AML) is an aggressive cancer of the blood and bone marrow that requires immediate treatment upon diagnosis. Early detection of AML is difficult as patients do not present symptoms in the pre-leukemic phase and there are no known morphological abnormalities in the blood cells. Previous mouse model research demonstrates that structurally abnormal mitochondria emerge in pre-leukemic platelets, preceding detection of leukemic blasts or changes in blood cell count. Electron cryo-tomography (cryo-ET), a high-resolution imaging tool that reveals cell structure in its native state, can be used for high-throughput screening of such abnormalities. Here we analyze human platelets of AML patients and compare them to healthy controls. Using cellular cryo-ET and 3D segmentation, we have identified changes in the subcellular morphology of AML patient samples, including the abnormal mitochondria reported in mouse models and previously unidentified elongated dense granules. We believe this abnormal morphology is an indicator of AML progression in different patients. Future work looks to quantitatively characterize abnormal organelles and automate the segmentation process.

### **Structural and Functional Diversity of ClpP Proteases**

Kaleab Afework | Mentor: Francis Tsai

The Caseinolytic protease P (ClpP) is a conserved serine protease that plays an important role in mediating stress responses and in maintaining proteostasis in bacteria (bClpP) and mitochondria (hClpP). ClpP self-assembles into a barrel-shaped heptamer or tetradecamer that makes up the proteolytic core. The functional assembly requires binding of a hexameric ATPase component (e.g., ClpA or ClpX), which activates the protease and is required for protein unfolding and degradation. Prior research has characterized bClpP and hClpP independently. However, in this study we compare the structural composition and functional activities of these distinct proteases using size-exclusion chromatography with multi-angle light scattering (SEC-MALS) to assess the oligomeric states and a fluorescently labeled substrate degradation assay to assess their functional activities.

### **Exploring Methods to Concentrate Gold Nanoclusters while Maintaining Stability**

Fatima Akilo | Mentor: Matt Jones

Gold (Au) nanocluster surfactant composition influences gold nanoparticle stability. Stabilization of Au nanoclusters can be accomplished by synthesizing nanoclusters with different surfactants, such as double tail surfactants. Double tail surfactants pack more tightly and efficiently, which could increase Au nanocluster stability. Concentrating Au

nanoclusters is difficult as they are suspended in aqueous solution and sensitive to heating. Yet, centrifugation has shown promise in concentrating gold nanoclusters without the nanoclusters disintegrating. By increasing the concentration of Au<sub>32</sub> clusters, we believe that it will be easier to characterize various chemical properties relating to the clusters' ligand structure. Nanoclusters were synthesized with a mixture of CTAB and dicylildimethylammonium bromide (C14), which is a double tail surfactant composed of two fourteen carbon alkyl chains. Then, the Au nanoclusters were centrifuged at 20,300 rpm and 0 degrees C for one hour. The supernatant was assessed with UV-Vis spectroscopy to determine concentration changes. Stabilizing and concentrating gold nanoclusters has many synthesis applications.

## **Determining the Role of p53 in Enteric Progenitor Cells During the Development of the Enteric Nervous System of Zebrafish**

Jorge Arnez Gonzales | Mentor: Rodrigo Moreno Campos

The Enteric Nervous System (ENS) is a network of neurons and glia, derived from neural crest cells (NCC), and is responsible for controlling the digestive tract functions. Genetic mutations such as in the gene RET, cause developmental problems in ENS, including Hirschprung disease (HSCR), a pathology characterized by the absence of ENS along the gut. Based on our NCC zebrafish scRNA seq Atlas, *tfp53*, which encodes for the protein p53, appears to play a role in the development of the ENS, but the mechanisms are not well understood. Consequently, we identified putative p53 expressing ENS cells in zebrafish embryos, and we generated zebrafish *tfp53* CRISPRants, as well as conducted a drug treatment using p53 inhibitors and activators in order to observe possible changes in NCC proliferation and migration. We evaluated the p53-mediated cell death and DNA damage response by measuring the production of Caspase3 and  $\gamma$ H2AX, respectively, in zebrafish undergoing drug treatments. Results revealed that inhibiting p53 with PFT- $\alpha$  induced an HSCR-like zebrafish phenotype with an increase in  $\gamma$ H2AX, showing an increase in dsDNA breaks and suggesting a DNA repair role for p53 in ENS development.

## **Establishing in vitro culture of stem cells in the planarian *Schmidtea mediterranea***

Hannah Ashraf, Jasmine Xiong | Mentor: Blair Benham-Pyle

The planarian *Schmidtea mediterranea* has pluripotent adult stem cells that maintain adult tissues and fuel whole-body regeneration. Mechanistic study and genetic perturbation of planarian stem cells is limited by an inability to maintain or expand stem cells ex vivo. Previous methods maintained potency for only 48 hours with no evidence for stem cell expansion. Our goal is to establish an in vitro culture method that maintains stem cell potency and facilitates expansion. Ex vivo cell division of mammalian iPSCs and hESCs requires inhibition of several signaling pathways. Therefore, we screened an assortment of inhibitors (PD 032590, CHIR 99021, G66983, and XAV 939) commonly used in mammalian stem cell culture and determined if pathway inhibition promoted planarian stem cell expansion and potency. EdU incorporation was used to evaluate S phase cell division at different time points after plating and various live/dead and organelle stains were used to measure cellular health. Future work will measure expression of common stem cell markers and the ability of cultured cells to rescue lethally irradiated animals after transplantation.



## **Exoplanet Habitability: Magnetic Habitability and ‘Goldilocks’ Planets**

Anthony Atkinson | Mentor: David Alexander

Often, the working definition of exoplanet habitability requires that only the following condition be met: the planet must be able to host liquid water on its surface. This is known as the Circumstellar Habitable Zone (CHZ); the planets are known as ‘Goldilocks’ planets as they are ‘just right’ for life. This criterion covers many factors that make life on Earth a possibility, but not all. A significant threat to life on Earth is space weather, driven by the activity of the Sun and its interaction with the Earth. Space weather can, at best, make for breathtaking aurora, and, at worst, disable technology and irradiate and ionize organic compounds on a planet’s surface. Thus, we must include another criterion to define the potential for habitability: the planet must possess a strong enough magnetic field to shield itself from intense stellar weather. This work introduces the definition of the ‘magnetic habitability’ criterion and applies it to current exoplanet surveys. We find that 16 Goldilocks (CHZ) exoplanets also satisfy the magnetic habitability criterion, making them strong targets for searches for life elsewhere in the galaxy.

## **Examining Age-Dependent Retinal Phenotypes of Genetic Knockout Mice**

Anish Attarde | Mentor: Yingbin Fu

Age-related macular degeneration (AMD) is an ophthalmological condition that is projected to grow by 92 million patients worldwide over the next 20 years. Options for treatment only provide a short-term renewal of vision before eventual resistance to anti-VEGF medication removes any effectiveness. Thus, there remains a clear lack of options for long-term preservation of visual acuity. As a result, in order to detect AMD before progression, there needs to be a greater understanding of genotypic tendencies through screening. The project focuses on establishing a set protocol to screen mice with genetic knockouts categorized into young, intermediate, and old age groups to determine the differences between their phenotypes. ICG dye and Heidelberg imaging were employed to image C57BIGJ, LDLR<sup>-/-</sup>, AIBP<sup>-/-</sup>, and AIBP<sup>-/-</sup>LDLR<sup>-/-</sup> knockout mice. These images revealed that genetic knockouts contain a much higher level of leukocytic migration than control groups. This is especially exacerbated by double gene knockouts where brighter spots and deeper lesions are visualized using OCT. Similarly, an increase in age was seen to positively affect the intensity of immune cells on the retina.

## **ABCA4-Based Retinal Degenerative Disease Causing Alternated Transcriptome Expression in Human Retinal Organoids**

Yourong Bao | Mentor: Zhen Zuo

Inherited retinal degeneration (IRD) is a type of neurodegeneration involving progressive photoreceptor cell death in human retinas and causes severe vision loss or blindness. It is known to be associated with common eye diseases like Retinitis Pigmentosa and Stargardt Disease. Scientists have identified more than hundreds of genetic loci in the human retina that may be the cause of inherited retinal degeneration. The traditional mouse models are often applied when testing the effect of individual gene knockouts, yet limitations of animal models prevent accurate prediction of the outcome of specific gene mutations in human retinas. Thus, using patients with ABCA4-related Stargardt Disease (STGD) as the

experimental model, we tested the potential of cone-rich human retinal organoids in predicting IRD-diseased individuals by checking their alternated transcriptome profiling during the retina's early developmental stage. In addition, we also found a list of differentially expressed genes between human retinal organoids derived from the STGD patients and from the wild type, which are candidates of genes in the retina that are affected by the ABCA4 mutation.

### **Visual assessment of enhancement pattern on pre-treatment computed tomography imaging associates with survival for patients with unresectable intrahepatic cholangiocarcinoma**

Madeline Belknap | Mentor: Brian De

Intrahepatic cholangiocarcinoma (ICC) is an aggressive cancer diagnosed in approximately 800 patients in the US annually for which prognostication is challenging. Our lab has previously shown that the enhancement of the tumor on pre-treatment contrast CT imaging correlates with the biological characteristics of the tumor and overall survival (OS) of patients with ICC. We sought to determine the relationship between visually apparent enhancement patterns and OS for these patients. We retrospectively reviewed imaging from 97 patients diagnosed with unresectable ICC between 2001 and 2021. The enhancement pattern of the dominant liver tumor was categorized as hyperenhancing (HR; lighter in color relative to surrounding parenchyma), or hypoenhancing (HO; darker). Patient vital status and date of last follow up were recorded and correlates with survival were determined using univariate Cox proportional hazards modeling. There was a significant difference in survival seen between these cohorts; median OS was 26 months for HO and 34 months for HR. Visual assessment of tumor enhancement for ICC patients is associated with survival and may be used to tailor patient prognosis and treatment.

### **How do microbes influence aggressive behavior and social network structure in *D.melanogaster*?**

Raleigh Bellard | Mentor: Julia Saltz

Microbial communities play a vital role in the development and health of their host; in turn the host is physiologically and behaviorally influenced by their presence. Often, how microbial communities influence social behavior is studied in isolated, pairwise interactions. However, this approach ignores how microbes can influence dyadic interactions within larger social groups. Aggression is an important social behavior which influences social structures. I conducted an experiment with *D. melanogaster* to investigate the differences in aggressive behavior and social networking in social groups of axenic flies, who have their entire microbial communities removed (n= 22 groups), and flies with an intact microbiome (n = 13 groups). *D.melanogaster* is amenable to this study, as they have a well characterized set of aggressive behaviors and form social groups. Studying the influence of microbes on aggressive behavior contributes to our understanding of their impact on social networking and social behavior in group settings.

### **Determining the Point of Development of Primary Castration Resistance in Myc-CAP BMP4 Tumors**

Akash Bhat | Mentor: Sumit Subudhi

Prostate cancer (PCa) is the second leading cause of death in men worldwide, and often metastasizes to the bone, which is a site of resistance to most of our standard therapies. This study aims to develop a new preclinical model of bone-forming PCa tumors in mice, which could be used to examine the mechanisms of treatment resistance. Our group previously overexpressed bone morphogenetic protein 4 (BMP4) in Myc-CAP, a mouse prostate cancer cell line, to promote bone formation. In this study, Myc-CAP and Myc-CAP BMP4 cells were injected intrafemorally into syngeneic wild-type FVB mice, and following chemical castration with degarelix, tumor volumes were measured weekly using MRI imaging. Currently, we are characterizing the tumor growth curves *in vivo* with and without chemical castration. Once this is completed, we will use this novel model to understand the molecular mechanisms mediating resistance to therapies, like immunotherapies.

## **Mapping RelA and cJUN Kinetics with the PAM2-ODN Treatment**

Keerthi Bhoda | Mentor: Pantaleon Jezreel

The Evans lab harnesses the innate immune responses of lung epithelial cells using a highly synergistic combination of Pam2-CSK4, a Toll-like receptor (TLR) 2/6 ligand, and ODN M362, a TLR 9/9 ligand, that can broadly prevent respiratory infections in immortalized human (HBEC3-KT) and mouse (MLE-15) cells and in mice. However, despite knowing the involvement of multiple transcription factors (such as NF-KB, AP-1, STATs) behind this phenomenon, called “inducible resistance”, their signaling dynamics and cooperation have not been fully described. Imaging flow cytometry (IFC) can be used to study these transcription factor signaling dynamics. MLE-15 cells were exposed to the PAM2-ODN treatment and collected for IFC at 4-hour intervals across a 28-hour time course. Cells were fixed and permeabilized before staining for viability, transcription factors (NF-kB RelA and AP-1 cJUN), and the nuclear marker, DAPI. Cells were imaged using the Amnis ISX Imaging Flow Cytometer and analyzed to detect nuclear translocation and colocalization. Through IFC, the nuclear internalization of RelA and cJUN, along with the synergy of these transcription factors with the PAM2-ODN treatment was shown.

## **How does social information influence fruit fly aggression?**

Patricia Bilderback | Mentor: Marina Hutchins

Social information describes the transmission of non-genetic information through various cues among individuals. Individuals may use this information in differing ways to determine their own behavior going forward and appropriate responses. Animals may obtain social information from the aggressive behaviors of others, which may then lead to responses of increased or decreased aggressive behaviors towards that individual. To better understand how social information is utilized among fruit flies ((*Drosophila melanogaster*)), we assembled arenas that contained two male fruit flies and allowed them to fight. Eavesdropper flies were able to watch the aggressive encounter and then interact with the two males. Flies that did not receive social information were also allowed to interact with the two males as a control. Aggressive behaviors were video-recorded. Understanding how social information is utilized may help us better understand social behaviors.

## **IRF3 Localization and Transcriptional Regulation in Pam2/ODN-stimulated Lung Epithelial Cells**

Jack Bodnar | Mentor: Michael Longmire

Lung epithelial cells are sufficient to combat many inhaled pathogens through an innate immune response induced by the synergistic Toll-like Receptor agonists Pam2CSK4 and ODN M362 (Pam2/ODN). This study reports the localization and gene regulation of the Interferon Regulatory Factor 3 (IRF3) transcription factor in the Pam2/ODN-induced innate immune response in lung epithelial cells. While the activation of IRF3 and its subsequent gene regulation is well-known in infection, understanding these processes in response to Pam2/ODN is necessary to fully characterize the mechanisms of protection conferred by the treatment. The human HBEC3-KT and mouse MLE-15 lung epithelial cell lines were each assessed for IRF3 nuclear translocation and gene expression via immunoblotting, immunofluorescence microscopy, and RT-qPCR. Here we find that Pam2/ODN treatment results in IRF3 nuclear translocation and differential expression of IRF3-regulated genes. These results support our hypothesis that Pam2/ODN activates IRF3 signaling, which may contribute to the Pam2/ODN-induced protection against pneumonia.

## **Prospects for Searches for Leptoquarks at a Muon Ion Collider**

Prathik Boyelia | Mentor: Darin Acosta

Leptoquarks are hypothetical bosons that interact with both leptons and quarks, and are predicted by many beyond Standard Model (SM) theories. Experimental results such as the measurement of the branching ratios of the decay of the B meson to a Kaon and a lepton antilepton pair, or the measurement of the muon magnetic moment hint at a deviation from the SM. These disagreements can be explained by leptoquarks. Historically, leptoquark searches have been limited to models that couple quarks and leptons of the same generation. The Muon Ion Collider can serve as a rich testing tool for leptoquarks with mixed couplings. In particular, we study leptoquarks coupling to muons, and bottom or strange quarks and antiquarks. In this project we use various Monte Carlo frameworks such as MadGraph5 and Pythia to study the cross sections and differential cross sections, with respect to various kinematic variables, of different relevant processes. We observe a peak corresponding to the s channel resonance of one leptoquark process, and we further investigate the signal to SM background significance of our generated events.

## **Emotion Dysregulation Associated with Greater Depressive Symptoms and Memory for Details**

Jacob Buergler | Mentor: Kayla Clark

Regulating our emotions is integral to our everyday experiences, and successful emotion regulation can impact our memory of emotional experiences. Individuals with depression show emotion dysregulation and impairments in memory. The hippocampus and amygdala are brain regions important for the emotional modulation of memory and are impacted in depression. As such, we aimed to examine the habitual use of emotion regulation strategies and emotion dysregulation in relation to memory performance and depressive symptoms. We measured lure discrimination index (LDI), a memory measure that relies on the hippocampus and highly detailed memory (Leal & Yassa, 2018). We

found no significant relationship between habitual use of emotion regulation strategies and LDI. However, we found a significant relationship between higher depressive symptoms and better LDI that depended on greater emotion dysregulation. This suggests that individuals who are depressed and struggle with emotion dysregulation may focus on the unnecessary details of an experience. Forgetting details may function as a beneficial sorting mechanism which helps healthy people discard information that is not important to remember.

## **Caddisfly Morphology May Track the Dispersal of Genetically Engineered Crops in Streams**

Ethan Bull | Mentor: Scott Egan

Genetically Engineered (GE) crops often introduce foreign proteins into non-target areas. Bt-Cry is one such protein with an insecticidal effect. Generally used to modify corn and cotton, Bt-Cry has been previously proven to negatively affect non-target organisms that live in ecosystems close to agricultural sites. One such organism is the caddisfly (Order: Trichoptera). Closely related to Lepidopterans, we believe that the Bt-Cry that targets moths and butterfly larvae will also have an adverse impact on caddisflies. We used a morphological analysis of over 1000 caddisflies in the net-spinning family Hydropsychidae. We first subdivided caddisflies by morphospecies and instar, then compared caddisfly body size between agriculturally developed and natural areas. Our prior analysis of 300 samples seemed to indicate that there is no significant fitness effect on caddisflies in the family Hydropsychidae due to the presence of Bt-Cry, and we expect the remaining data to indicate the same.

## **Generating More Efficient Base Pair Insertions Using Cas9-AbiK Fusion**

Angela Cai, Vanessa Lee, Audrey Nguyen, Caleb Solorzano | Mentor: Carrie McNeil

CRISPR Cas9 has been used to study gene function in zebrafish, but targeting insertions in some genes and in non-coding regions is challenging using Cas9 alone. Fusing Cas9 with a reverse transcriptase (AbiK) would theoretically allow for more specific genome insertions. We hope to create an AbiK-Cas9 fusion that will provide researchers with a tool for more efficiently studying zebrafish embryonic development. To create the AbiK-Cas9 fusion, we will clone the AbiK gene and Cas9 in a plasmid vector using Polymerase Chain Reaction (PCR) and Gibson Assembly. We predict that this AbiK-Cas9 fused protein will successfully produce increased targeted insertions compared to Cas9 alone. These insertions will generate meaningful mutations without human bias which can result in observable changes in zebrafish embryonic development. This development could be a valuable tool in studying reverse genetics in zebrafish and other organisms.

## **Investigating the Role of Baseline Late Positive Potential in Predicting Changes in Drug Demand Over Treatment for Cocaine Use Disorder**

Doug Calvillo | Mentor: Heather Webber

Current treatments for cocaine use disorder (CUD) often fail to reach desired clinical efficacy and are not equally effective across individuals. Identification of individual differences can result in more personalized and efficient CUD treatment outcomes. The present study investigated the late positive potential (LPP) as a predictor of changes in cocaine demand over time among individuals receiving treatment for CUD. We hypothesized higher baseline LPP toward cocaine cues relative to pleasant cues would be associated with greater cocaine demand over the course of treatment. The study enrolled 59 treatment-seeking individuals with moderate-to-severe CUD who completed baseline measures of motivational value, including cocaine demand and LPP difference scores towards drug-related, pleasant, and neutral cues. Cocaine demand was also assessed after two and four weeks of treatment. Participants received four weeks of high magnitude contingency management treatment and individual counseling. Analyses will leverage Bayesian generalized linear mixed modeling to assess the predictive effects of LPP, Time, and the interaction between LPP and Time on cocaine demand over CM treatment.

### **Indirect Genetic Effects on Evolutionary Trap Susceptibility in *Drosophila melanogaster***

Elena Carmichael, Alexandra Serrato, Elim Taffere | Mentor: Julia Saltz  
Evolutionary traps pose an alarming threat to the maintenance of Earth's ecosystems. These are situations where an animal's evolved response to a cue becomes detrimental to its fitness when that cue is decoupled from its typical association. Little is known about why organisms fall for traps, but previous research indicates that social interactions may play a significant role as individuals are often influenced by others in an environment. Moreover, the possibility of Genotype x Genotype (GxG) interactions could point to the existence of indirect genetic effects (IGEs). Increasing our understanding of IGEs could equip us to combat evolutionary traps. In this study, we investigated GxG interactions between focal genotypes and their trappability in *Drosophila melanogaster*. We observed how differences in response to an apple cider vinegar trap are influenced by an individual's genotype and sex, and the genotype and behavior of the opposite sex. Preliminary findings demonstrate a negative relationship between the number of females trapped and the number of offspring enclosed in the first 24 hours, confirming the premise that survival is a good proxy for reproductive success.

### **Uncovering Regulators of the ESRE Mitochondrial Surveillance Network**

Alicia Chan, Michelle Miao | Mentor: Natasha Kirienko  
The Ethanol and Stress Response Element (ESRE) is a conserved mitochondrial surveillance pathway known to be upregulated by reactive oxygen species. However, specific transcription factors that bind the ESRE sequence remain unknown. Screening a library of ~1,500 transcription factors and kinases in *Caenorhabditis elegans* using a 3XESRE::GFP reporter yielded 9 kinase and 3 transcription factor hits whose knockdown reduced ESRE expression. Knocking down 10 of the 12 hits had no effect on the activation of two other mitochondrial surveillance pathways: MAPKmt and UPRmt. Two of the kinases were removed, as they were not specific to ESRE. Of the 10 hits, RNAi of F23B12.7, a bZIP transcription factor and CEBPZ ortholog, had the strongest effect in preventing ESRE activation. Comparison of F23B12.7 to other bZIP transcription factors

determined that F23B12.7(RNAi) mitigated ESRE activation more than any other bZIP tested. Preliminary results from Liquid-killing and Slow-killing *Pseudomonas aeruginosa* assays indicated that F23B12.7 may be the only strong ESRE regulator amongst the 3 transcription factor hits. Further validation in a subsequent series of experiments is underway.

## **Molecular Nanomachines Stimulate Ca<sup>2+</sup> Release in HEK and spHEK Cells**

Gautam Chaudry | Mentor: James Tour

Molecular nanomachines are small molecules that contain benzene rings and a sulfur heterocycle that rotates when exposed to visible light due to cis/trans isomerization of the double bond connecting two cyclohexene groups. These molecules have previously been demonstrated to kill cancer cells or infectious bacteria when activated with visible light. Recently, these nanomachines were shown to stimulate muscle contraction in both in-vivo and in-vitro model systems by controlling intracellular calcium signaling. The nanomachines localize between the endoplasmic reticulum and the cell membrane and release Ca<sup>2+</sup> when activated through the IP<sub>3</sub> pathway. Here, we aim to investigate the effects of laser power, stimulation time, and imaging buffer on the resulting calcium responses from cells treated with nanomachines. Using Human Embryonic Kidney (HEK) cells and spiking HEK cells, various nanomachines were used to stimulate Ca<sup>2+</sup> release. Increased laser power leads to an increase in Ca<sup>2+</sup> release, yet increased stimulation time generally leads to cell death. Similarly, an external Ca<sup>2+</sup> buffer leads to an increase in calcium release by a factor of two compared to a non-external Ca<sup>2+</sup> buffer.

## ***In vivo* base editing with engineered chemically inducible split adenosine base editor**

Kelly Chee | Mentor: Zane Zeng

CF is an autosomal recessive disease caused by deletions or single nucleotide polymorphisms (SNPs) in the cystic fibrosis transmembrane regulator (CFTR) gene. Lacking functional CFTRs causes salt and fluid homeostasis impairment on the exocellular membrane, which leads to pulmonary infections, malabsorption syndrome and multi-organ dysfunction. Unlike traditional therapies with transient treatments, genetic therapies can target any CF-causing mutations on the CFTR gene and offer a permanent solution to the disease. Gene-editing tools such as CRISPR-Cas proteins demonstrate success in site-specific gene disruption and manipulation. Still, they all have trade-offs among precision, efficiency, and targeting scope. I will be investigating the possibility of developing a more accurate Adenine Base Editor (ABE) with a broader targeting scope. I plan to utilize rational mutagenesis, directed evolution, and other protein engineering approaches to improve the reported ABEs. In addition, I plan to leverage the developed variants to create disease-relevant stable cell lines for CF functional studies and to thoroughly explore CF-causing mutations that the developed technology can treat.

## **Evaluating the molecular mechanism of G-quadruplex stabilization in ATRX-deficient sarcoma**

Brandon Chen | Mentor: Jason Huse

Mutational inactivation of histone chaperone  $\alpha$ -thalassaemia/mental retardation X-linked (ATRX) is a defining molecular alteration in sarcoma. Loss of function in ATRX leads to the buildup of abnormal DNA secondary structures known as G-quadruplexes (G4s). The buildup of G4s in ATRX-deficient cancers causes replication stress and DNA damage, leading to transcriptional dysregulation and genomic instability. Here, we demonstrate a dose-sensitive response to G4 stabilization in ATRX-deficient sarcomas with G4 stabilizer CX-5461. Specificity was confirmed by cell viability assays. G4 stabilization exhibited G2/M cell cycle arrest in ATRX-deficient sarcoma. Additionally, G4 stabilization upregulated ATR and ATM pathways in ATRX-deficient cells, indicating enhanced replication stress and DNA damage. Immunofluorescence supports this with enhanced nuclear foci of RPA32 and  $\gamma$ H2AX. Our findings suggest an interplay between the activation of ATR/ATM pathways and cell cycle arrest upon G4 stabilization. Next steps are testing G4 stabilization with other DNA-damaging therapies. Our work outlines mechanisms of action and efficacy for novel therapeutic strategies for ATRX-deficient cancers.

## **A Potential Role for YcjX in the Modification of tRNA**

James Cheng | Mentor: Francis Tsai

Exposure to acute and chronic stress triggers the expression of stress-response proteins to protect cells from damage. Through heat shock induction, YcjX is upregulated at levels comparable to major heat shock proteins; however, the mechanism and function YcjX is unknown. The crystal structure showed that YcjX is a GTP-binding protein consisting of a Ras-like domain at its core and featuring several novel insertions, including an N-terminal insertion, a helical domain, and a C-terminal insertion. Missense mutations of key residues within the helical and core domains show changes in protein solubility indicating impairment in protein folding and function. Here, we propose that YcjX is involved in the post-transcriptional modification of tRNA for its proper function in protein synthesis. Furthermore, as a multidomain protein, YcjX may concurrently play a role in managing membrane stress through these tRNA modifications.

## **Investigating the Dominant Negative Mechanism of the R406H Variant in STXBP1 Encephalopathy**

Teresa Chin | Mentor: Joanne Kim

STXBP1 encephalopathy (STXBP1-E) is a rare neurodevelopmental disorder characterized by epileptic seizures and intellectual and motor deficiencies. The R406H missense variant, in particular, may cause STXBP1-E through a dominant negative mechanism. In this process, mutant proteins can form insoluble aggregates that may recruit wildtype STXBP1, further reducing functional protein levels. As endogenous STXBP1 functions as a chaperone for  $\alpha$ -synuclein, formation of STXBP1 aggregates may also reduce the level of functional  $\alpha$ -synuclein proteins. However, the study of STXBP1 missense variants has been largely limited to in vitro cell cultures and their pathology in animal models is mostly unknown. Thus, I will explore the relative protein levels and the aggregate formation of STXBP1 in various brain regions of R406H mutant and wildtype



mice. I will separate the protein extracts into soluble and insoluble fractions and compare the relative levels of STXBP1. I will also examine whether the total level and the solubility of  $\alpha$ -synuclein are altered in mutant mice. This study will elucidate the protein dynamics of the R406H variant and provide knowledge for understanding the disease mechanism.

## **Function of Nephronectin during Early Ocular Development in Mice**

Evelyn Chiu | Mentor: Matthew Garis

The extracellular matrix (ECM) provides a crucial environment for embryonic development, contributing to key processes such as cell adhesion, migration, and differentiation. Nephronectin (Npnt), an ECM protein reported to regulate these processes, was recently found to be expressed in murine ocular development, but its role in the mouse cornea remains largely unknown. Building upon previous work on avian corneas, we hypothesized that Npnt positively regulates cellular migration and/or cell proliferation. Mouse corneas were collected at embryonic stages E12, E13, and E14, and histological techniques were used to analyze differences in cell proliferation between wild type and mutant embryos. Preliminary results indicate possible differences in cell proliferation. Additionally, some mutant mice display an observable neurocranial defect. Pending results will compare ocular phenotypes between wild type mice with mutant mice that show this extreme phenotype. These results will contribute to a larger investigation on the function of Npnt during murine corneal development, and future research may apply this knowledge toward examining the interplay involved in matrix signaling.

## **The Circadian Rhythm Regulators FMR1 and RBM4 Modulate Neurodegeneration in a *Drosophila* Model of Spinocerebellar Ataxia Type 1**

Rhea Cho | Mentor: Ismael Al-Ramahi

Issues with sleep and wake cycles are one of the most commonly-cited reasons for entry of individuals with neurodegenerative disease into assisted living. Circadian dysfunction has been associated with the progression of neurodegenerative diseases such as Parkinson's, Alzheimer's, Spinocerebellar ataxia type 1 (SCA1), and related dementias. Here we use a well-characterized *Drosophila* model of SCA1 that expresses 82Q expanded repeats in the neurotoxicity-inducing protein ataxin-1 (ATXN1). ATXN1 has been found to interfere with the functions of proteins via nuclear colocalization. Following a genetic screen, we identified fragile X messenger ribonucleoprotein 1 (FMR1) and endogenous RNA-binding protein RBM4, two proteins associated with the regulation of circadian rhythm, as modifiers of ATXN1-induced neuronal dysfunction. While previous research suggests that a disruption in circadian rhythm patterns may be a risk factor for developing dementias, the physical and genetic interactions among FMR1, RBM4, and ATXN1 are not well characterized. Here, we show that these proteins modulate neuronal loss through physical and neurodegenerative interactions with ATXN1.

## **Metal-to-Insulator Transition in Sr<sub>2</sub>Mn<sub>3</sub>As<sub>2</sub>O<sub>2</sub>**

Emma Codianne | Mentor: Emilia Morosan

In condensed matter physics, the compound Sr<sub>2</sub>Mn<sub>3</sub>As<sub>2</sub>O<sub>2</sub> is a Mott insulator, which is a material that demonstrates insulating behavior when measured, contradictory to band

structure calculations that find no band gap and suggest it is conducting. Chemical tuning can be used to drive Mott insulators into a critical regime straddling the local-to-itinerant magnetic moment, in which emergent states like unconventional superconductivity or correlated topology are predicted to occur. Our approach to reaching this crossover region with Sr<sub>2</sub>Mn<sub>3</sub>As<sub>2</sub>O<sub>2</sub> single crystals includes tuning the oxygen content of the compound, using both time-dependent and temperature-dependent annealing in either oxygen-rich or oxygen-poor atmospheres. We have successfully observed this crossover manifesting in resistivity measurements going from insulating to metallic behavior, and we have seen a faster decrease in resistivity at lower temperatures. In further experiments, we will increase the oxygen deficiency of Sr<sub>2</sub>Mn<sub>3</sub>As<sub>2</sub>O<sub>2</sub> in hopes of observing superconductivity.

## **Investigating Various ESKAPE Pathogens' Survival in Activated Versus Inactivated Bovine Calf Serum**

Aubrey Cui | Mentor: Yousif Shamoo

The prolific use of antibiotics in medical treatment has rapidly expanded the prevalence of drug resistance in human pathogens. Today, six separate pathogens, each represented by a letter in the acronym “ESKAPE,” have emerged with especially dangerous drug-resistant and virulent phenotypes. Though much work has been done to explain how ESKAPE pathogens evolve antibiotic resistance in traditional laboratory media, more research is needed to understand the impact of the complement system and serum nutrients on pathogen viability. Using heat-inactivated and active sera growth assays containing iron and glucose supplements, we seek to investigate the response of various ESKAPE pathogens to bovine calf serum, a medium with proteins and nutrients that resemble human serum, to explore how a selective growth medium can potentially mediate antibiotic tolerance or resistance. Each ESKAPE pathogen displays different initial survivability and growth over the course of multiple passages. Further study into the mechanisms behind these contrasting responses to serum can be leveraged to develop effective treatments that counteract the ESKAPE pathogens' drug-evading prowess.

## **Identifying mMAP4 Protein Interactors using Co-Immunoprecipitation**

Camila DeAlba | Mentor: Lathan Lucas

Microtubules are an essential part of the cellular cytoskeleton. In skeletal muscle cells (myofibers) microtubules are required for cell function. Microtubule dynamics can be regulated by microtubule-associated proteins (MAPs). Microtubule-associated protein 4 (MAP4), is a key MAP expressed in myofibers. One isoform of MAP4 is expressed ubiquitously (uMAP4) and is known to stabilize and regulate microtubules. Another MAP4 isoform is solely expressed in mature myofibers (mMAP4). mMAP4 includes a 3,180bp alternatively spliced exon (exon 8) which is not present in uMAP4. The function of mMAP4 is unknown. It is suspected that the exon 8 protein product of mMAP4 is structurally disordered, and therefore functions through protein-protein interactions. Identifying mMAP4 interactions, specifically within the exon 8 protein product, would elucidate its function. We optimized an in vivo electroporation system to express the exon 8 protein product in mature mouse skeletal muscle. To isolate the overexpressed exon 8 protein region and its interactome, we used co-immunoprecipitation (co-IP) followed by

mass spectroscopy. We will validate our hits and determine the unique interactome of mMAP4.

### **Microfluidic Emulsions as a Model of Chronic Lung Infection for Experimental Evolution of *Pseudomonas aeruginosa***

Saoirse Disney-McKeethen | Mentor: Yousif Shamoo

Antibiotic resistance is a global health crisis. Understanding mechanisms of resistance through experimental evolution allows for the design of novel therapies to combat resistance. However, in vitro evolution is typically done in bulk flask cultures that lack the spatial structure often present at infection sites and are highly competitive, leading to the loss of less fit strains. Microfluidic emulsions can be used to create spatially structured, low competition environments that potentiate clinically relevant evolutionary trajectories that cannot be seen in a traditional flask evolution experiment. Our project aimed to adapt *P. aeruginosa* to colistin in microemulsions and compare the evolutionary trajectories observed in flask, large droplet, and small droplet environments through longitudinal whole genome analysis. We observed mutations in our lowest competition populations linked to hallmark adaptations to a cystic fibrosis lung environment, such as loss of motility and loss of O antigen biosynthesis. These mutations were quickly lost when droplet populations were grown in flask, indicating these trajectories can only be recapitulated in a spatially structured environment.

### **Plant Pollinator Ecology and Edge Dynamics in Chihuahuan Desert Shrubs**

Kenna Dixon | Mentor: Tom Miller

The diversity of plant population quantities is often a result of their dependence on that species' density in its environment. Density-dependence affects the plant population range dynamics and fitness. Plant pollinators can affect density dependence positively and negatively by their own ecology. We can also examine whether plant pollinator abundance and density is dependent on plant density. We measure pollinator density and variation and compare it to plant population density and abundance.

### **Behavioral Diversity of Bird Leg Uses Inferred from Citizen Science Videos**

Nicolette Douvas | Mentor: Rafael Marcondes

There is limited research on bird legs and their different uses. The Furnariidae family, specifically, displays a great variety of leg uses and functions. Lack of technology and difficult fieldwork logistics have made this difficult to study, but with citizen science we now have an unprecedented amount of video documentation of bird behavior. The goal of this project is to assess the feasibility of extracting leg use information for Furnariids on a massive scale, using videos from Cornell University's Macaulay Library, the world's premier scientific archive of natural history audiovisual resources. I am using the software BORIS to extract and organize behavioral data on leg use from over 200 videos, allowing me to construct ethograms. So far, I have observed that leg use in this family, though very varied, clusters into six main categories: hopping, walking, climbing, perching, standing, and upside-down movements. These descriptions will serve as a base for future evolutionary studies of bird legs, including addressing the relationships between their form and function.

## **Examining the Role of the FGF Signaling Pathway in the Development of the *Danio rerio* Enteric Nervous System**

Pamela Duarte | Mentor: Lucia Rivas

The enteric nervous system (ENS) is an arrangement of neurons and cells in the gut that regulates motility, water balance, and hormone secretions. ENS development occurs as neural crest cells (NCC) transition into enteric neural progenitor cells, which move into gut tissue to become neurons. Data from the Uribe lab's single-cell RNA sequencing on zebrafish NCC derivatives has uncovered the expression of Fibroblast Growth Factor (FGF) signaling pathway encoding genes in the enteric neuron lineage, with high expression in enteric neurons. We examined when the FGF signaling pathway is active during zebrafish ENS development. Visualization of FGF signaling reporter activity in developing neurons, using the double transgenic line (-8.3phox2bb-cfos:H2a-mCherry;dusp6:GFP), revealed FGF activity within enteric neurons *in vivo*. By using an inhibitor (SU5402) that blocks FGF receptor activity, and confocal imaging, we confirmed FGF signaling pathway inhibition. Furthermore, *fgf13b* was a candidate gene for further investigation, thus we used CRISPR/Cas9 mediated mutagenesis to examine *fgf13b* mutation on ENS development. These data help show when FGF signaling is involved in ENS development.

## **Development of Optogenetic Control of the AMP Kinase Pathway in *C. Albicans***

Jacob Duplantis | Mentor: Michael Gustin

*Candida albicans*, a fungus that often infects humans, is a model system to study the adenosine monophosphate-activated protein kinase (AMPK) pathway. In *C. albicans*, this pathway is thought to have effects on hyphal growth. Optogenetics is the use of light to alter gene expression or gene product activity in a cell. The use of a photoactivatable peptide allows temporal and spatial control of AMPK inhibition. Using DNA digestion ligation, this project has been able to transform the SC5314 strain of *C. albicans* with DNA that confers a peptide that when 515 nm light is shone, exposes an AMPK inhibitory (AIP) peptide. This peptide is comprised of a light receiving portion based on the mVenus fluorescent protein. This peptide is joined with a linker that binds it to the AIP peptide. Proper insertion has been demonstrated using nourseothricin plates to test the strains nourseothricin resistance and agarose gel assays. The strains successfully developed resistance, indicating proper insertion of the experimental plasmid. Biofilm studies using specific wavelengths will allow for the evaluation of the transformation and for utilization of the inhibition properties of the peptide.

## **Exploring Genetic Links between Pediatric and Adult Neurodegenerative Disorders**

Oladipupo Fagbongbe | Mentor: Laurie Robak

Parkinson's disease (PD) is an age-associated, progressive neurodegenerative disorder that affects motor function and cognition. Patients who do not meet the clinical criteria for PD may still suffer from PD symptoms (parkinsonism). *GBA*, a gene that causes the lysosomal storage disorder (LSD) Gaucher disease, is a potent risk allele for PD. Emerging evidence suggests that other LSDs may provide an avenue for studying PD pathogenesis. Genetic variants in the other 53 human LSD genes, as a group, are associated with an

increased risk of PD, but the specific LSD genes that confer this risk and the unique phenotypic signatures exhibited by carriers are largely unknown. Therefore, we developed a family-based model to determine associations between LSD genes and PD risk. We collected comprehensive pedigrees from families with histories of LSDs and assessed family members for PD symptoms. We also quantified the extent to which PD motor and cognitive symptoms manifested in LSD carriers. The results of this study could identify novel genetic risk factors for PD and phenotypic markers in carriers of LSD genes, thereby improving our understanding of PD heritability and risk assessment.

## **Variations in Fibroblast Metabolism Underlie Distinct Wound Healing**

Fayiz Faruk | Mentor: Swathi Balaji

Wound healing involves several phases and various cells including the fibroblasts that produce ECM and fibrosis. Wound repair is energy-intensive, requiring metabolic processes such as glycolysis and oxidative phosphorylation to produce the ATP needed to fuel the proliferation, migration, and ECM production of fibroblasts (FB). We hypothesize that a shift towards aerobic glycolysis, i.e., the Warburg effect, in dermal FB regulates the extent of fibrosis and scar formation. Here, we evaluated the expression of PKM2, a rate-limiting enzyme in glycolysis, and Hsp27, a key mitochondrial chaperone protein in patient FB cell lines with high scar (HS) and low scar (LS) phenotypes. Western blotting and proteomic analysis showed that there was increased expression of p-PKM2 and p-Hsp-27 and its downstream AKT/p38/MAPK/Erk signaling in HS fibroblasts. Treatment of patient FB with p-Hsp27 and p38 inhibitor SB203580 showed that inhibition of p-Hsp27 attenuated the differences between LS and HS patient FB. These findings suggest that increased fibrosis and scarring are associated with metabolic shifts toward aerobic glycolysis in FB, which can be therapeutically targeted to attenuate fibrosis.

## **Exploring How Mitochondrial Dynamics Influences Ferroptosis in Pancreatic Ductal Adenocarcinoma**

Aishani Gargapati | Mentor: Emily Caggiano

Pancreatic Ductal Adenocarcinoma (PDAC) is a lethal cancer with a 5-year survival rate of 11% due to delayed detection, early metastasis, and lack of targeted therapies. Changes in mitochondrial morphology and function are enacted via the complementary processes of fission and fusion, which are in a constantly changing balance. While normal cells are fusion-dominant with tubular mitochondria, PDAC exhibits a disrupted balance, displaying increased fission and punctate mitochondria. These fragmented mitochondria are essential to sustaining the energetic needs of PDAC cells. We previously established that inducing mitochondrial fusion in PDAC delayed tumor growth and hypothesized that fusion may promote ferroptosis as a mechanism of tumor suppression. We demonstrate that the ferroptosis inducer RAS-selective lethal 3 decreases the cell viability of PDAC cells in a dose-dependent manner and that the loss of the fission-promoting protein Dynamin-related protein 1 increases PDAC's sensitivity to ferroptosis. Determining the mechanism involved in the tumor suppression promoted by mitochondrial fusion opens avenues of developing targeted therapies for PDAC patients.

## **A Cytotoxic HLA Molecule Protects Adoptive NK Cells from Recipient Allorejection**

Lauren Ginn | Mentor: Robin Parihar

Adoptive natural killer (NK) cell therapies involve infusion of activated NK cells into patients to mediate anti-tumor effects. NK cells can be isolated from the patient themselves (autologous) or a matched healthy donor (allogeneic). Though allogeneic NK cell therapies have displayed promising anti-tumor efficacy in clinical trials, their long-term persistence post-infusion is limited due to elimination by the patient's alloreactive T cells. This study aims to protect allogeneic NK cell therapies from patient T cell-mediated rejection. To do this, NK cells were successfully genetically engineered to express a cytotoxic HLA molecule, the Chimeric HLA Accessory Receptor (CHAR) (79% CHAR expression). To assess the effectiveness of the CHAR in mitigating NK allorejection, allogeneic CHAR-NK cells and T cells were cultured in a mixed lymphocyte reaction assay for 12 days. Unmodified allogeneic NK cells were depleted (84% reduction), while CHAR-NK cells expanded (40% expansion). CHAR remained detectable on NK cells after 12 days (70% expression). This highlights the CHAR's potential to improve the persistence of allogeneic NK cell therapies by minimizing T cell-mediated rejection.

## **Focusing on the mechanism behind why angiogenesis occurs in response to loss/inhibition of CAMKK2**

Pavithr Goli | Mentor: Thomas Pulliam

Inhibiting the expression of the CAMKK2 gene is a critical part of prostate cancer (PC) research. Castration surgery is a form of treatment that PC is able to resist. However, PC is able to become resistant to this form of treatment, leading to castration-resistant prostate cancer (CRPC). Recent literature discussing this topic has provided strong evidence pointing toward the conclusion that the CAMKK2 gene is an activator for PC growth and this gene is necessary for CRPC development. Further, these studies have also identified a signaling pathway (CAMKK2-AMPK-ULK1 pathway) promoting the growth of PC through autophagy. This specific project has the goal of further studying CRPC genes (like CAMKK2) and identifying the numerous resistance mechanisms that are used by these genes to overcome castration treatment. Angiogenesis has been hypothesized to be a resistance mechanism utilized by PC to provide growth factors and nutrients when CAMKK2 is inhibited. The results will be focused on how angiogenesis in CRPC cells is affected by applicable current treatments along with characterizing CAMKK2 dynamics with therapeutic chemicals such as oligomycin & IACS10759.

## **Targeting the NRF2 Oncogenic Pathway Shows Efficacy with Hepatoblastoma**

Saiabhiroop Govindu | Mentor: Sarah Woodfield

Hepatoblastoma (HB) is the most common pediatric primary liver tumor. Previous work showed NFE2L2/NRF2 mutations in 11% of HB patients, all with high-risk tumors. NRF2 is a transcription factor that directly activates multiple target genes, and carcinogenic effects of NFE2L2 are potentially dependent on mTOR/AKT. Thus, we tested HB cell lines with the mTOR inhibitor sapanisertib and AKT inhibitors MK-2206 and perifosine to establish efficacy and mechanism of action. NRF2 target expression was upregulated in

vascular invasion tumor sub-clones and in chemoresistant tumor cells. Sapanisertib, MK-2206, and perifosine killed cell lines with high NRF2 activity but did not kill cell lines with low NRF2 activity. HepT1 cells treated with a combination of sapanisertib and cisplatin showed decreased cell viability. Immunoblotting showed decreased expression of phosphorylated AKT for HepT1 cells and no expression of phosphorylated AKT for HepG2 cells treated with sapanisertib. Knock-down of NFE2L2 significantly decreased proliferation of HepT1 cells. Inhibition of mTOR/AKT shows strong in vitro efficacy in HB and correlates with the presence of an NFE2L2 mutation and/or NQO1 expression.

## **Skin Color Development and CRISPR Genome Editing in the Brown Anole Lizard *Anolis sagrei***

Zoe Griffin | Mentor: Sarah Woodfield

Animal communication is variable across species. *Anolis* lizards (anoles) rely almost exclusively on visual communication cues. Anoles have a colorful skin flap under their neck (dewlap) they unfurl in social interactions. The color of the dewlap is hypothesized to be important for species-specific communication in complex environments. Though pigment development is not well understood in anoles, recent advancements in CRISPR/Cas technology have provided the opportunity to study the genetic basis of reptilian skin pigmentation through genome manipulation. Here, we investigate the role of Scavenger Receptor Class B Member 1 *scarb1* in skin color development of the brown anole, *Anolis sagrei*. *Scarb1* expression has been correlated with yellow coloration in anole skin and is shown to regulate the development of yellow pigment in other vertebrate species. The end goal of this project is to utilize high-efficiency CRISPR guide RNAs to create mutant individuals to further our understanding of the role of *scarb1* in reptile pigment development. These data will strengthen our understanding of the development of color-based signals in an understudied phylum.

## **Oxygen Isotope Fractionation During Cyanobacterial Photosynthesis**

Lingkun Guo | Mentor: Yeung Laurence

Marine primary productivity is crucial to the biological pump, which sequesters inorganic carbon from the atmosphere through photosynthesis and transports it to the ocean interior where it's stored as organic carbon. To understand how climate change may impact the biosphere, it's necessary to improve methods for quantifying primary productivity. The triple-oxygen isotope (TOI) method uses  $^{18}\text{O}/^{16}\text{O}$  and  $^{17}\text{O}/^{16}\text{O}$  ratios of dissolved  $\text{O}_2$  in the ocean to constrain primary productivity. Understanding how oxygen isotope fractionation varies under nutrient stress improves interpretation of field observations. In this study, cyanobacteria *Synechocystis* are inoculated under various nitrate concentrations and the TOI composition of photosynthetic  $\text{O}_2$  is analyzed. This study generates new data on the clumped isotope composition of photosynthetic  $\text{O}_2$ , which describes the degree of randomness in the distribution of rare oxygen isotopes ( $^{17}\text{O}$  and  $^{18}\text{O}$ ) in  $\text{O}_2$  molecules. Results show a larger oxygen isotope fractionation with more nitrate limitation, and that the TOI and clumped isotope composition of photosynthetic  $\text{O}_2$  can be used together to elucidate the mechanism of cyanobacterial photosynthesis.

## **Establishment of bioprospecting pipeline for novel antibiotics through *Streptomyces* isolation from gall-forming wasps**

Rodolfo Gutierrez | Mentor: James Chappell

Increased resistance to current antibiotics poses a significant threat to global health. Most antibiotics have historically originated from *Streptomyces*, a genus of bacteria largely observed in soil. However, uncharacterized *Streptomyces* species producing novel antibiotics are being found to be increasingly prevalent in unique symbiotic relationships with higher-level organisms. This collaborative project is attempting to establish a bioprospecting pipeline to discover these novel antibiotics from eukaryotic-derived Actinobacteria, using gall-forming wasp as a model through two methods – antimicrobial testing using wasp-associated isolates and whole microbiome sequencing that gives insight to gall environments – which have successfully been done on a trial basis. Here, we show analyses of microbiomes from several gall-wasp species found on the Rice University as well as results from initial antifungal testing.

## **Assessment of Interferon Scores in Juvenile Dermatomyositis (JDM) Patients**

Sophia Hafner | Mentor: Vogel Tiphonie

Interferon 1 signaling is upregulated in many autoimmune diseases, such as Juvenile Dermatomyositis (JDM). Interferon signatures have been quantified using a system of interferon scores for many inflammatory diseases. This project seeks to develop interferon scores for a pediatric JDM patient cohort in order to further understand the role of interferon 1 signaling in the pathology of JDM. Scores are then analyzed in conjunction with clinical data to determine any possible significant clinical markers of high IS. Methodology included PBMC isolation, RNA isolation, cDNA synthesis, RT-PCR, and calculation of interferon scores (IS).

## **Exploring temporally restricted MYCN overexpression effects on Neural Crest Cell development**

Thomas Hamre | Mentor: Rose Uribe

Neuroblastoma (NB) is a cancer of the sympathetic nervous system and arises primarily in the sympathetic ganglion chain and adrenal glands. NB accounts for 15% of pediatric cancer deaths, making it an important target for research. Additionally, NB patients that have particularly high-risk tumors experience poor outcomes even with modern multimodal treatments. A high percentage of these high-risk tumors are characterized by heightened levels of the transcription factor MYCN. As it has been suggested that aberrations during neural crest cell (NCC) development lead to NB tumor formation, in this project we aim to analyze the effect MYCN overexpression has on early NCC development. Injection of transposase and an appropriate vector containing the ((sox10)):MYCN-P2A-EGFP sequence into one-cell stage zebrafish embryos allows for the expression of human MYCN in developing NCCs under the control of the ((sox10)) promoter. Immunohistochemical assays then allow for the detection of MYCN and assessment of changes in NCC differentiation during early zebrafish development. Results will help elucidate the effect MYCN overexpression has on NCC populations and the early mechanisms of NB onset.



## **Impacts of tRNA Methyltransferase 1-like on tRNA Structure and Function**

Cindy Han | Mentor: Catherine Denicourt

Increasing evidence reveals RNA modifications dynamically regulate gene expression and stress responses. Transfer RNAs (tRNAs) are especially heavily modified. Studies show such modifications impact tRNA structure, function, and formation of tRNA-derived fragments (tRFs). Here, we investigate the poorly characterized tRNA methyltransferase 1-like (TRMT1L). Lab data indicates TRMT1L installs a N<sup>2</sup>,N<sup>2</sup>-dimethylguanosine (m<sup>2</sup>,2G) modification on specific tyrosine tRNA isodecoders at position 27. My preliminary data from denaturing polyacrylamide gel electrophoresis and northern blotting reveals TRMT1L KO cells generate novel cleavage fragments derived from tyrosine tRNAs. This suggests TRMT1L-mediated modification(s) may regulate tRF production under normal and oxidative stress conditions. Our findings may give insight on how the modification influences tRNA structural stability. Recent studies unveil roles of tRFs in translation modulation, cancer progression, etc. Future work includes determining the modification's impact on tRNA native structure and confirming TRMT1L function via re-expression experiments. Overall, this study will enrich our understanding of the epitranscriptome.

## **Investigation of Mitochondrial Morphology in Tumor Cells with Fused Mitochondria**

Maggie Han | Mentor: Matt Cribb

Pancreatic ductal adenocarcinoma (PDAC) is a highly lethal disease with minimal treatment options. Mitochondrial oxidative phosphorylation is necessary for PDAC growth. Previous research demonstrates that PDAC cells exhibit abnormally fragmented mitochondria that contribute to their oncogenic growth. Mitochondrial fission is promoted by oncogenic KRAS continuously activating DRP1. Additionally, PDAC is characterized by its hypoxic microenvironment which contributes to disease development and alters cell metabolism. Thus, we hypothesize that hypoxia promotes nuclear fission in tumor cells. To evaluate changes in mitochondrial morphology, PDAC tumor cells (KPC, PANC1) and breast tumor cells (4T1) were grown in normoxic and hypoxic conditions and stained with MitoTracker Orange. The results reveal that mitochondrial fission was prevalent in all three cell lines, and hypoxia did not cause additional fission. Given the extent of mitochondrial fission observed in cells grown in normoxia, hypoxia-mediated fission would be difficult to observe in the cell lines. Further investigation is needed to determine how hypoxia affects mitochondrial morphology in tumor cells with fused mitochondria.

## **Expression, Purification, and Analysis of the Human Astrovirus Capsid Protein VP90**

Mitchell Han | Mentor: Yizhi Tao

Human Astrovirus is an sRNA virus that is known to cause gastroenteritis, inflammatory pathogenesis, and various zoonotic infections. The structural protein, VP90, makes up the capsid protein of the virus. It is divided into several domains including the amino terminus, central region, and an acidic C-terminal domain. However, much more study on the structure and mechanism of VP90 is required to produce preventative measures.

Thus, expression, purification, and proper oligomerization of VP90 is necessary for further analysis, so most optimal conditions and reagents needed for proper isolation of VP90 is needed. To accomplish this, I ran various VP-90 constructs in protein expression protocols, using LB broth as growth medium and IPTG induction. The expressed cells were lysed with a NaCl buffer, and VP90 was eluded using Nickel Affinity Chromatography. Size exclusion chromatography was then used to further purify the protein based on its molecular weight. To determine success of purification, SDS-PAGE was used. The results showed that the 72-782 VP90 construct had the best purity, and conditions like a 300 mM NaCl lysis buffer was optimal in terms of purity and yield.

### ***In vitro* tools to study the effects of ApoE and ApoH on Lipoprotein(a)**

Nicholas He | Mentor: William Lagor

Lipoprotein(a) (Lp[a]), a liver-synthesized lipoprotein, is a major causal risk factor for atherosclerotic cardiovascular disease and calcific aortic valve disease. This study will seek to expand knowledge regarding Lp(a)'s metabolism and connection to cardiovascular disease (CVD). Variants in the APOE and APOH genes are associated with Lp(a) levels through prior genome-wide association studies. Both genes' products influence Lp(a) levels, but their mechanisms for doing so are not known. To determine the effects of ApoE and ApoH on the metabolism of Lp(a), we will perform loss of function experiments using Clustered Regularly Interspaced Short Palindromic Repeats/Cas9 (CRISPR/Cas9) genome editing ((in vitro)) with the subsequent heterologous reintroduction of ApoE and ApoH variants. I designed 3 guide RNA sequences targeting each gene. Guides were tested in HEK293T cells, Inference of CRISPR Edits (ICE) analysis was performed, and the most efficient guide per gene was selected. Creating Huh7 (human hepatoma) ApoE and ApoH knock out stable cell lines will allow us to test how different isoforms of these proteins affect Lp(a) and give us a better understanding of Lp(a) metabolism.

### **Novel Treatment for Cisplatin Resistance in Retinoblastomas**

That Hein | Mentor: Shin Crystal

Retinoblastomas are a form of cancer that affect the eye and are particularly potent in children. The survival rate of retinoblastomas are below 30% in underdeveloped countries. The current most cost-efficient treatment is DNA damaging therapies, specifically in the form of cisplatin but consistent treatment of cisplatin often leads to cisplatin resistance, leading to the need of higher dosage to reach the same therapeutic effects. This is deleterious to the health of the patient as cisplatin has many negative side effects that are further emphasized as dosage is increased. Thus, treatments that decrease cisplatin resistance are heavily desired in treatment for retinoblastomas. We propose that the resistance of cisplatin in retinoblastomas arise from the use of mutagenic translesion synthesis (TLS) within cancer cells to bypass DNA damage, and thus cotherapy of cisplatin with TLS inhibitors in the form of REV-1 inhibition will decrease retinoblastoma resistance to cisplatin.

## **Social Exposure's Impact on Aggression in *Drosophila melanogaster***

Autumn Hildebrand | Mentor: Julia Saltz

Interacting with others in a social context may allow individuals to learn social competency. Social information production, that is, information that is derived from another individual through observation, can dictate how aggressive the initial individual is. I predict that exposure to other individuals during the early stages of life coupled with a social audience upon maturation plays a significant role in how an individual will behave. In this experiment, I am using 4 genotypes of *Drosophila melanogaster* that have either been socially isolated or socially exposed for four days and afterward, recording their aggressive behaviors against a standard opponent. Changes in aggression for flies in the presence or absence of an observer varied with socially competent or socially isolated treatments would suggest social learning via social information plays a significant role in dictating an individual's behavior.

## **Spatial Navigation Task Using Auditory Cues in a Real-World Environment**

Amy Ho | Mentor: Caleb Kemere

Place cell activation has largely been researched through visual stimuli; however, this task investigates spatial navigation of mice using auditory cues on a real-world circular track to compare to prior experiments in a virtual environment. Spatial navigation was measured through anticipatory licking of reward wells which deposit water. Two starting points and two associated reward wells were used to mitigate use of environmental cues. Four speakers around the track played an auditory A B C B pattern of sounds for each trial, with the correct reward well placed after B. Results demonstrate 2 out of 3 mice navigated this environment with median success rates of 65.5% and 82.9%, indicating they had successful spatial navigation compared to chance behavior; additional testing of naïve cohorts of mice tentatively demonstrate similar results. Therefore, mice likely utilize auditory cues in learning and navigating environments. Further work will focus on recording changes in place cell activation throughout the task.

## **Identification and Isolation of Intracellular Bacterial Species Associated with the Coral Reef Symbiont *Symbiodiniaceae* by Protoplast Formation and Lysis**

Charlotte Hoebig, Amanda Hogan, Victoria Santos | Mentor: Michael Gustin

Coral reefs are one of the most diverse habitats on Earth, acting as a key participant in ecosystem services worldwide. Reefs are comprised of coral skeletons that house the Cnidarian animals, which in turn host *Symbiodiniaceae*, a photosynthetic dinoflagellate. However, under modern warming conditions, the symbiosis between corals and microalgae is beginning to break down. The oxidative stress theory of coral bleaching postulates that this is due to an overproduction of reactive oxygen species, triggered by a malfunction in the algae photosystems. The Gustin lab theorizes that there may be a way to artificially enhance the antioxidant capacity of *Symbiodinium*. For my research, I aim to characterize another layer of symbiosis present, between *Symbiodiniaceae* and its intracellular bacteria. Prior research suggests that exchange pathways between the two groups exist. Seeking a novel method of mitigating harmful effects of warming on reefs,

this study aims to identify intracellular bacteria via lysis of algae protoplasts. In the future, I hope to selectively remove species of interest, in order to understand how re-addition may influence thermotolerance under heat-stress conditions.

## **Elucidating the Mechanism of Secondary Light-switching Response of Rhenium(II) Dipyridophenazine Complex Toward Amyloid- $\beta$ Aggregation**

Cole Holladay | Mentor: Angel Martí

Amyloid- $\beta$  (A $\beta$ ) peptide aggregation has been linked to the development of Alzheimer's disease. Earlier efforts from the Martí group proposed the use of d<sup>6</sup> metal complexes to probe and modify A $\beta$  aggregates. The photoluminescence emission of the rhenium(II) dipyridophenazine complex ([Re(CO)<sub>3</sub>(dppz)(Py)]<sup>+</sup>) increased in the presence of A $\beta$  fibrils. Remarkably, another emission enhancement of the mixture of [Re(CO)<sub>3</sub>(dppz)(Py)]<sup>+</sup> and A $\beta$  fibrils was observed when irradiated with UV light. Previous studies showed that [Re(CO)<sub>3</sub>(dppz)(Py)]<sup>+</sup> oxidized methionine 35 of A $\beta$  fibrils upon UV irradiation. However, the mechanism of this secondary response has not been established. To determine this, dimethyl sulfide (DMS) and the [Re(CO)<sub>3</sub>(dppz)(Py)]<sup>+</sup> complex are used to mimic the microenvironment of the rhenium complex bound to A $\beta$ . This solution is irradiated with UV light (365 nm) to cause the emission enhancement. Following High Performance Liquid Chromatography (HPLC), mass spectroscopy and <sup>1</sup>H NMR data provide information that elucidates the structures of two important interactions between A $\beta$  and [Re(CO)<sub>3</sub>(dppz)(Py)]<sup>+</sup>, from which the mechanism in question can be deduced.

## **Preliminary Findings on the Effects of a 12-Week Fitbit Intervention in the Average Steps of Hispanic Adolescents with Obesity**

Anna Hsu | Mentor: Erica Soltero

Hispanic adolescents are disproportionately affected by obesity, which highlights the need to promote health behaviors like physical activity. Digital health tools include activity trackers and text-messages; however, few studies have used them with Hispanic youth. This study examined the preliminary effects of a 12-week Fitbit and text-message intervention on daily steps of Hispanic adolescents with obesity. Participants were randomized to an intervention (N=11) or control group (N=6). Youth in the intervention received a Fitbit device and text-messages designed to foster motivation. Youth in the control received a Fitbit device and national activity guidelines. At baseline, control youth achieved more steps/day (M=6887.67 $\pm$ 401.179 vs M=5961.75 $\pm$ 1840.01). The average steps peaked at week 6 for both groups and by week 12, intervention youth (M=4737.50 $\pm$ 1508.68) achieved more daily steps compared to control youth (M=4680.50 $\pm$ 2312.95). There were no significant differences between groups in daily steps (p>0.05). Preliminary findings demonstrate that text messages increase steps compared to the Fitbit device alone. More research is needed to determine how to sustain increases in activity.

## **An Abnormal Extracellular Environment May Contribute to Bowel Dysfunction in Hirschsprung Disease**

Britney Hsu | Mentor: Lily Cheng

Hirschsprung disease (HSCR) is defined by a deficit of enteric neurons in the distal bowel. The proximal ganglionic bowel is considered normal, but many patients continue to experience bowel dysfunction after surgery. We aim to characterize differences in extracellular matrix (ECM) composition and mechanoreceptor Piezo1 expression in ganglionic HSCR colon compared to wild-type (WT) colon. Ganglionic and distal aganglionic colon were collected from *Ednr<sup>b</sup>-/-* mice (HSCR; n=3) and healthy, WT littermates (n=3). Hematoxylin-eosin, trichrome, and immunofluorescence staining captured structure, collagen content, and Piezo1 expression. RT-qPCR measured expression of ECM-related genes and Piezo1. Piezo1 expression decreased in ganglionic HSCR colon compared to WT. HSCR ganglionic colon had both significantly greater collagen content and notably different expression of 12 ECM genes (including collagen turnover and fibrosis regulating genes) compared to WT. Ganglionic proximal HSCR colon had increased collagen, dysregulated ECM gene expression, and decreased Piezo1 expression when compared to proximal WT colon. These differences may contribute to abnormal ganglionic bowel function in HSCR.

## **Investigating the Role of the Switch Motifs in the YcjX GTPase**

James Hwang | Mentor: Francis Tsai

YcjX is a conserved protein in gram-negative bacteria, which is highly upregulated in response to acute stress. The structure of YcjX features the Ras-like GTP-binding domain at its core. The guanine nucleotide-dependent conformational changes in most G proteins are confined to the canonical switch 1 and switch 2 motifs, which are both present in YcjX. However, the catalytic dependence of YcjX lies in the conserved switch 1 motif and a novel switch 2' motif. The role of the canonical switch 2 motif in YcjX is not well understood. The research objective of this project was to make (*Escherichia coli*) YcjX mutant proteins in order to understand the effect of site-specific mutations on protein function. Specifically, we used targeted mutagenesis and (*in silico*) methods to investigate the role of the canonical switch motifs in YcjX. We also reviewed the scientific literature to speculate on the biological function of YcjX, and I will present my findings at this meeting.

## **Characterizing the Role of Peroxins in Pexophagy**

Priscilla Ibrahim | Mentor: Kathryn Smith

Peroxisomes have numerous critical roles in the metabolic and biochemical processes within eukaryotic cells. Peroxisomal structures and functions have been studied in mammals, yeast, and plants in order to gain better understanding of their role in cellular activities. These essential organelles are regulated via the cellular process of autophagy, termed pexophagy. Peroxins, or PEX proteins are necessary for peroxisome function and attractive candidates for roles in pexophagy. Here we take advantage of the ease of working with *Arabidopsis* to study the role of PEX10 and other described peroxins within pexophagy. We have developed one tri-fluorescent reporter system to query the role of a specific domain of PEX10 and will also use a di-fluorescent system deployed in various peroxin mutants. We will perform microscopy and biomolecular assays on mutant plants expressing our reporters to identify the role of these peroxins in pexophagy and

peroxisomal morphology. These findings can impact our understanding of metabolic diseases attributed to peroxin mutations as well as the way researchers study and manipulate peroxisomes in other models such as crop species.

## **Engineering Useful Gene Therapy Vector Properties in the Baculovirus**

Tanya Jain | Mentor: Tanya Jain

"Gene therapies are commonly delivered via viral methods, such as through lentivirus and adeno-associated virus (AAV). However, many gene editing methods would benefit from more complex engineering, which cannot be packaged into the little space that current viral vectors provide. Baculovirus has a much larger carrying capacity, but comes with its own limitations, including transduction efficiency and complement protection. This research aims to improve baculovirus function in mammalian cells by expressing new proteins on its membrane, with the larger goal of creating and delivering targeted, inducible CRISPR-Cas9 gene circuits. Circuits containing polH and p10 insect promoters, specific surface proteins, and GFP were created to determine how the surface proteins affected transduction efficiency and protection from the complement system. The data indicated that an anti-CD34 single chain antibody improved transduction efficiency, wild-type baculovirus performed better than baculovirus with VSV-G and VSVG-ED when a complement system was present, and that baculovirus could transduce Jurkats wells, although the addition of sodium butyrate (NaB) was required to see gene expression.

## **An Analysis of Differential Synaptogenesis in Neural Organoids Co-Cultured with Excessive Thrombospondin-1 and EGFL**

Ronak Jaisalmeria | Mentor: Ronak Jaisalmeria

After traumatic neural injuries, stroke, and neurodegeneration, regeneration and recovery of synaptic networks are highly impaired. Thus, investigating therapies to increase the rate of synaptogenesis has high translational potential to repair neural networks and subsequently gain return of motor and cognitive function. Our previous studies have found that coculturing human neurons with astrocytes lead to increased synaptogenesis – which gives a basis to explore the mechanisms underlying this phenomenon. One of promising astrocyte-secreted synaptogenic protein is Thrombospondin-1 (THBS1). This protein contains a specific domain known as EGFL that is suspected to bind to specific neuronal receptors and induce synapse formation. However, studies have been limited to rodent models and traditional monolayer cell cultures. Here, to test the potential of THBS1 and EGFL in a model system more appropriate for the human nervous system, we aimed to test their effect on synaptogenesis using bioengineered neural organoids from human pluripotent stem cells.

## **Evaluating the Dysregulation of Autophagy on Age-Related Ectopic Neurite Branching in *Caenorhabditis elegans***

Dheerj Jasuja | Mentor: Andrea Stavoe

Aging is characterized by reductions in memory formation, problem-solving, and other cognitive abilities. To restore neuronal function, it is imperative to develop a deeper understanding of the cellular processes underlying aging. At a morphological level, previous research has found that *C. elegans* nematodes spontaneously develop ectopic

neurite branches as they age, which act as a measurable phenotype of aging. Another hallmark of aging is a decrease in autophagy. Notably, previous studies found that autophagic function in primary mouse neurons could be restored by overexpressing WIPI2B (which is analogous to ATG-18 in *C. Elegans*), but not phosphomimetic WIPI2B. However, we wanted to understand the functional outcomes of decreases in autophagy. We thus compared the rate and length of neurite branching among wild-type, phospho-dead, phosphomimetic, and null *atg-18* worms. We found that the phosphomimetic and null worms had significantly reduced lifespans while only the null strain had significantly more branching than wild-type. These results suggest that inhibiting autophagy is sufficient to drive accelerated aging while other mechanisms induce branching.

### **Decline in SETDB1-mediated Silencing of Endogenous Retroviruses Contributes to Cellular Aging in *Mus musculus***

Kevin Jin | Mentor: Yejing Ge

Transposable elements (transposons) comprise forty percent of the mammalian genome, although most are suppressed in adult somatic tissues. Although transposons have been shown to exhibit activity in early development, their activity in adult tissues is unknown. Elevated transposon levels have been observed in adult pathologies such as autoimmune diseases, cancer, and aging; thus, further studies into their regulation are necessary. SETDB1 is a histone methyltransferase that gradually declines during aging. Bioinformatic analysis comparing SETDB1 ChIPseq and histone 3 lysine 9 trimethylation (H3K9me3) ChIPseq revealed that conditional ablation of *Setdb1* leads to reduction of H3K9me3 at SETDB1 loci concentrated in regions containing endogenous retroviruses (ERVs), a type of transposon. In addition, histological examination of *Setdb1* deficient mice shows a premature aging phenotype characterized by reiterated fugitive hair cycles. Interestingly, the premature aging phenotype can be partially rescued using antiviral drugs and genetic deletion of the AIM2 inflammasome. These findings indicate that SETDB1 plays a vital role in the regulation of ERVs and the process of aging.

### **Investigating the Involvement of a Mutated Lysosomal Tubular Network in *atlastin*-Correlated Protein Aggregation in *Drosophila melanogaster***

Prisha Jonnalagadda | Mentor: Saurabh Srivastav

Spastic paraplegia is a group of neuromuscular degenerative disorders that cause lower body muscle weakness and eventually, even immobility. On a cellular level, spastic paraplegia is also correlated to polyubiquitinated protein aggregation in the cytoplasm. The gene *atlastin* is hypothesized to be involved with this abnormality, but there is no definite explanation for the mechanism through which this buildup occurs. This study utilizes *Drosophila melanogaster* to investigate the differences between wildtype and *atlastin*-mutant lysosomal tubular arrangements in order to hypothesize that a malformation of the lysosome is correlated with the aggregation of proteins in malfunctioning cells. The results of this investigation suggest that the *atlastin* knockout experimental subjects have sparse tubular formations in the reticular and inner layers, illustrating a clear difference from the wildtype lysosome. In the future, more detailed research considering *atlastin*-mutant lysosomes may help further establish the pathway of causality between the *atlastin* gene and polyubiquitinated protein aggregates.

## **Identifying Candidate Causal Variants at QT interval GWAS Loci Using Linkage Disequilibrium and Overlap with Human Left Ventricle Open Chromatin Regions**

Supraja Kadagandla | Mentor: Ashish Kapoor

In the U.S., heart disease is the leading cause of death. The QT interval on an electrocardiogram measures the time for cardiac ventricular repolarization, is moderately heritable, and prolongation or shortening of QT interval is associated with cardiovascular morbidity/mortality. Genome-wide association studies of QT interval variation in the general population have identified dozens of genetic loci but the underlying molecular mechanisms remain largely unknown. With the hypothesis that causal variants at these loci likely regulate gene expression, bioinformatics methods were used to identify candidate cis-regulatory elements (CREs) in human heart left ventricle tissue. DNase-seq and ATAC-seq experiments, genomic assays identifying open chromatin regions that are hallmarks of CREs, from the ENCODE Project were processed using SAMtools and BEDtools, and used for calling peaks with MACS2. The candidate variants from the QT interval associated loci will be filtered for overlap with these putative CREs to identify variants for functional studies. Ultimately, this will allow for a better understanding of variants, genes, and their mechanisms of action underlying QT interval variation.

## **Analysis of single-cell RNA data through BayesPrism and SingleR**

Olivia Kaneko | Mentor: Rinki Ratna Priya

Age-related macular degeneration (AMD), in which the retina progressively atrophies, is the main contributor to irreversible blindness in the elderly. The retina is made up of many different cell types, but their distinct role in AMD pathology is not well understood as most studies are done at the tissue level. Measuring the proportions of retinal cell types allows us to identify disease-relevant cell types that can serve as markers of disease progression. Single-cell sequencing methods allow us to uncover more cell-type specific information than tissue-level sequencing, but at the cost of smaller sample sizes and cost inefficiency. Therefore, we utilize gene expression data obtained through both tissue and single-cell sequencing methods. We analyze a dataset consisting of 103,622 single-cell sequenced cells annotated automatically with SingleR, constructing a retinal cell reference that allows us to observe nine cell types in the retina. We then apply this reference to deconvolute, or find the cell proportions, of bulk data via Bayesian analysis in BayesPrism. This allows us to measure cell type proportions in the retina and track changes in cell types in disease.

## **Social Behavior of *D. melanogaster* in the context of Evolutionary Traps**

Ishani Kaul | Mentor: Julia Saltz

This project intends to determine if there is a relationship between the sociability of *Drosophila melanogaster* and their trappability. Based on the premise that individuals learn from other individuals, it is hypothesized that less social individuals will be less susceptible to traps. Artificial selection was imposed on the treatment group of flies to select for less social flies that were not susceptible to traps. Utilizing group-size arenas,



surviving individuals were tracked based on group sizes. Statistical analysis of nine generations of *D. melanogaster* was conducted in R, yielding relatively similar median group sizes. For the t-test to determine significance, it was found that the fifth generation had a statistically significant difference in group sizes between the control and treatment. Further analysis will be conducted on generations and replicates to determine if there is a significant relationship between social behavior and trappability.

## **Examining the Impact of Glycoprotein LRG-1 on Endothelial Cells After a Subarachnoid Hemorrhage**

Harveen Kaur | Mentor: Harveen Kaur

As one of the most common reasons for mortality from stroke, subarachnoid hemorrhage (SAH) occurs when ruptured blood vessels in the brain cause bleeding in the space surrounding the brain. Roughly 30% SAH patients will suffer from delayed ischemic and neurological complications about one week after SAH which contributes to long-term disability and memory deficits. Since SAH has an average incidence age of 50, it is crucial to understand the cause(s) of delayed deficits and to identify a therapeutic target to prevent these additional conditions. Leucine-rich alpha-2 glycoprotein (LRG-1) is known to cause autoimmune and cardiovascular disease progression and promote angiogenesis. Our lab observed that LRG-1 levels are elevated 1 day after SAH in patients and LRG-1 is higher in patients who will develop delayed deficits. We recently also found a correlation between increased LRG-1 levels and neurological function after SAH in mice. Our hypothesis is that LRG-1 may serve as a potential biomarker for delayed ischemic deficits, and we believe that LRG-1 expression will increase in the presence of blood for human and mice brain endothelial cells after a subarachnoid hemorrhage.

## **Transcutaneous Electrical Nerve Stimulation in the Lower Extremity in Patients with Post-Acute COVID-19 Syndrome – A Randomized Clinical Trial**

Murtaza Kazmi | Mentor: Rasha Bara

40% of hospitalized COVID-19 patients have at least one rheumatic or musculoskeletal symptom 6 mos. after recovery, symptoms characteristic of Post-acute COVID-19 Syndrome (PACS). Transcutaneous electrical stimulation therapy (TENS) has been successful at managing symptoms for patients with fibromyalgia; so, we aim to test the efficacy and acceptability of daily TENS for PACS population. In this double-blinded study we randomized 18 patients with PACS-related symptoms in an active group (AG, n=10) or placebo group (PG, n=8). At baseline (BL), AG received at least 3-hour TENS while PG received 10% dosage. At 4 weeks (W), both groups were unblinded. PG received an active device while AG kept their device until 8W. 12 patients (AG, n=6 and PG, n=6) were assessed. Six patients were withdrawn due to low compliance. The AG experienced a non-significant reduction in pain intensity and severity and a non-significant increase in sensitivity. All patients agreed the device was easy to use but AG reported greater decreases in their fatigue and weakness relative to PG. This study showed promising trends, but increased sample size and improved compliance are needed to reach conclusive outcomes.

## **Enhancing the CRISPR Mechanisms using PARP1 in Danio Rerio**

Isha Khapre | Mentor: Daniel Wagner

The zebrafish, *Danio rerio*, is a prominent model organism used to understand the genetics of human development. *D. rerio* is a fast-growing species of fish with clear embryos, permitting researchers to conduct varied, repeatable experiments in a sustainable manner. Genetic tools such as CRISPR Cas9 have proven to be extremely beneficial in these studies allowing the generation of many mutant alleles. However, previous studies have shown the low efficiency of CRISPR Cas9 knock-ins and larger knockouts in *D. rerio*, which has limited the potential of this method to produce engineered genetic loci with the high efficiency found in other model organisms. The fast rate of cell division in *D. rerio* embryos likely interferes with the homologous recombination of CRISPR lesions. We hypothesize increasing Poly [ADP-ribose] polymerase1 (PARP1) activity at CRISPR included double stranded breaks may increase the rate of homologous recombination. PARP1 is known to be involved with homologous recombination and other DNA repair mechanisms. Utilizing a Cas9 PARP1 fusion protein and synthetic guide RNAs, we targeted the pigmentation gene *golden* to test if a Cas9 PARP fusion will alter genetic lesions.

## **Characterizing *pex3a pex3b* mutants in *Arabidopsis thaliana***

Mohammad Khuroo | Mentor: Ana Swearingen

Peroxisomes are organelles which have detoxifying functions within the cell and can be studied using *Arabidopsis thaliana* as a model organism. Intralumenal vesicles (ILVs) are spherical structures found within the peroxisome lumen and proteins localize to these internal membranes, including peroxins (PEX), which are proteins that help with peroxisomal biogenesis. PEX3 helps with early peroxisomal membrane protein import and may play a role in localization to ILVs. PEX3 has two isoforms: PEX3A and PEX3B. We have identified mutant lines that are homozygous for both *pex3a* and *pex3b-3* mutations and performed sucrose dependence and IBA resistance assays on these mutants to identify phenotypes. We isolated one homozygous embryonic lethal mutant line with a 1 bp indel in *pex3a* and three homozygous lines of viable *pex3a pex3b-3* mutants with either a missense mutation, 6 bp deletion, or 15 bp deletion in *pex3a*. Under light-grown conditions, these lines have not shown sucrose dependence or IBA resistance. We have crossed these mutants to lines expressing dual fluorescent reporters which will allow us to visualize ILVs in peroxisomes.

## **Synergistic Effects of Time-Restricted Feeding and Nobiletin on Healthy Circadian Aging**

Andrew Kim | Mentor: Eunju Kim

Our physiological health is regulated by circadian rhythms, a core biological clock that regulates key cellular processes; however, these circadian amplitudes dampen with age. Thus, as our body's metabolism and sleep cycle decline with age, prominent disorders like resistance to insulin and leptin that increases the risk of type II diabetes arise. Previous studies have noted time-restricted feeding (TRF) as an external cue that regulates amplitude of daily biological rhythms, as well as Nobiletin (NOB) as a circadian-amplitude enhancer that improves metabolic fitness in healthy aged mice; however, the combination effects of TRF and NOB have not yet been examined. We investigated the

synergistic effects of TRF with NOB on healthy aging by creating 4 treatment groups of ad libitum/TRF and control/NOB diets on aged mice. Glucose tolerance tests and ELISA assays have shown significant differences in total glucose, insulin, and leptin levels within the TRF/NOB combination group. Our preliminary sleep chamber data also revealed enhanced sleep quality from the combination group. Together, our study illustrates synergistic effects of time-restricted diet and nobiletin on healthy aging.

## **Nuclear import of the influenza D virus non-structural protein 1 (NS1D)**

Andrew Kim | Mentor: Jane Tao

Influenza D virus (IDV) is a newly discovered member in the family Orthomyxoviridae. IDV mainly infects cattle and small ruminants, costing the US feedlot industry about \$1 billion annually. It is known that influenza A virus (IAV), a distant relative of IDV, use importin  $\alpha/\beta$ -mediated nuclear import to deliver its nonstructural protein 1 (NS1A) to the host nuclei, where NS1A plays an important role in modulating host innate immunity by regulating host gene expression. In this project, I aimed to determine if that is the case for IDV, and investigated whether influenza virus D nonstructural protein 1 (NS1D) also forms a complex with importin  $\alpha$  (imp $\alpha$ ). Protein purification methods and gel filtration assays indicated a possible NS1D and imp $\alpha$  complex, showing that NS1D had an affinity for imp $\alpha$  like its relative, NS1A. I plan to further delineate the molecular basis of this interaction by solving the structure of the complex using X-ray crystallography. For now, my findings form a strong foundation for further inquiries concerning IDV infection mechanisms and host interactions mediated by NS1D.

## **Utilizing CcaSR to Engineer Optogenetic Control of Hydra Neuropeptides**

Jae Kim | Mentor: John Lazar

Bacterial biosensing aims to engineer bacterial cells to respond to various extracellular and intracellular stimuli and has applications across medicine, agriculture, and industry. In the past, all bacterial biosensors have been developed for the exponential growth phase. However, bacteria exist almost entirely in the stationary phase in real-world applications. CcaSR, an optogenetic bacterial biosensor, has recently been developed into a variant that functions in the stationary phase. I characterized the expression dynamics of CcaSR that lead to this functional system by dynamically monitoring GFP-tagged CcaS/CcaR expression variants through the exponential and stationary phases. I am further developing applications of this technology, a method to optogenetically control neuropeptide/nitric oxide production in the gut of Hydra. I have cloned functional variants of the neuropeptides FR-amide1/2 and a nitric oxide synthase under the control of CcaSR, and have probed their ability to be expressed through functional GFP-tagged variants. This would be the first case of bacterial biosensing modulating an organism's behavior, opening doors to various medical and industrial applications.

## **The Development of Pediatric Acute Myeloid Leukemia (AML) Murine Models**

Julia Kim | Mentor: Alexandra Stevens

Acute Myeloid Leukemia (AML) is a condition when the bone marrow fails to produce functional granulocytes and monocytes. The differences in cytogenetic mutations and epigenetic markers between pediatric and adult AML calls for clinical investigations that examine the responses to chemotherapy agents specifically in the pediatric population. Such research is in critical need because AML is one of the leading causes of deaths in pediatric patients. The Stevens lab addresses the gap in pediatric AML (pAML) research by generating murine models of pAML. The bone marrow and pheresis samples collected from patients are injected into immunodeficient mice. The peripheral blood of injected mice are assessed with flow cytometry for successful engraftment of patient samples. Once confirmed by comparing the short tandem repeats (STR) and DNA/RNA sequences with the original patient samples, the murine models can be used in experiments for chemotherapy treatments. Some samples have produced successful models, but the effort of expanding model diversity needs to be continued to specifically focus on patients that have relapsed or had poor responses to current chemotherapy treatments.

## **Controlling T-Cell Transcription through Dynamically Regulated Synthetic Transcription Factors**

Kayla Kim | Mentor: Glenna Foight

This study aims to control the localization of a synthetic transcription factor (synTF) in order to regulate the transcription of a designated reporter. Current methods of combating T-cell exhaustion to enhance CAR-T cell therapies for solid tumors rely on constitutive overexpression or knockout of transcription factors but they cannot respond to the different state changes that cells go through. Therefore, we'll use nucleocytoplasmic localization tags (NCTags) made from post-translationally regulated nuclear localization and export signals, that can sense different stimuli and dynamically translocate in and out of the nucleus. We'll fuse NCTags to synTFs and regulate transcription of a fluorescent protein reporter. We intend to correlate the localization of the NCTags in response to stimulators and inhibitors to the transcription of the reporter using flow cytometry and confocal microscopy. These findings will establish an assay that will be used to test the control of NCTags to regulate transcription of desired outputs in response to tumor microenvironment conditions, like the formation of reactive oxygen species (ROS), as a proof-of-concept for enhancing cell therapies.

## **Exploring AP-1 as the Primary Enhancer Underlying Exercise-Induced Metabolic Effects**

Lana Kim | Mentor: Lana Kim

Physical exercise has many metabolic benefits, but the underlying mechanisms are not completely understood. Here, we conducted global nuclear run-on sequencing (GRO-seq) in mouse skeletal muscles to systematically characterize the enhancers responsive to acute treadmill exercise. We found that activator protein 1 (AP-1) as the top enriched transcription factor in exercise-induced enhancers. AP-1 is a family of transcription factors mainly composed of Jun, Fos and ATF (activating transcription factor) that have been found to contribute to oncogenesis. The function of AP-1 in skeletal muscle and

metabolism is unclear. We found that AP-1 loss-of-function in mouse muscles impaired glucose tolerance and muscle contractile performance. These results demonstrate the role of AP-1 in muscle physiology and systemic glucose metabolism. We are working to clarify the AP-1 downstream effectors in muscle performance and glucose metabolism in response to exercise.

## **Comparing metabolic, mechanical, and electrical stimulation to promote hiPSC-derived cardiomyocyte maturation**

Stephanie Kim | Mentor: Fernanda Mesquita

The study of human cardiomyocytes (CM) is critical in understanding the molecular mechanisms and therapeutic methods of cardiovascular diseases. Through culture and differentiation, human induced pluripotent stem cells (hiPSCs) have become a vital resource in producing CM for future studies. Maturation protocols including long-term cultivation, microtissue development, hormone treatment, and mechanical and electrical stimulation have been utilized to generate a near-fetal phenotype. A study of the most effective CM maturation protocol would enable hiPSC-derived CM (hiPSC-dCM) use in disease modeling and regenerative medicine. In this study, we compare the transcriptional signatures of structural, ECM, and metabolic-related genes of hiPSC-dCM under long-term cultivation (up to 180 days), and metabolic, mechanical, and electrical stimulation protocols. Our results suggest that the presence of stimulation expedites the hiPSC-dCM maturation process and ultimately decreases the cell culture time by at least 60 days compared to long-term cultivation. The ultimate goal is to combine the use of mature hiPSC-dCM with decellularized scaffold in advancing whole-heart engineering.

## **The Role of Fatty Liver in Ornithine Transcarbamylase (OTC) Deficiency**

Sara Koh | Mentor: Lindsay Burrage

Ornithine transcarbamylase (OTC) deficiency, an X-linked disorder, is the most common urea cycle disorder and is characterized by a wide phenotypic heterogeneity. Non-alcoholic fatty liver disease (NAFLD) is an accumulation of fat in the liver that can progress to non-alcoholic steatohepatitis (NASH), often associated with inflammation, damage, and scarring of the liver. Previous studies have shown reduced urea cycle function in individuals with NASH. Here, we investigated whether OTC deficiency accelerates the transition from NAFLD to NASH in a diet-induced NASH setting using the *Otcspf-ash* mouse model. A second objective was to test whether diet-induced NAFLD leads to a reduction of OTC enzyme activity and reduced urea cycle function in the setting of this OTC deficient mouse model. Wild-type males (*Otc+/y*), wild-type females (*Otc+/+*), hemizygous *Otcspf-ash* males (*Otcspf-ash/y*), and heterozygous *Otcspf-ash* females (*Otcspf-ash/+*) were placed on low-fat or high-fat diets for 24 weeks. Liver and serum were collected and analyzed at the end of the treatment period for markers of fibrosis and liver disease.

## **Determining the importance of interferon-gamma signaling in trained immunity**

Scott Koh | Mentor: Brandon Tran

Following an infectious exposure, innate immune cells process inflammatory stimulants and display trained immunity, an epigenetic reprogramming that leads to pro-inflammatory responses to subsequent infections. Since trained immunity can persist for over a year, literature suggests that hematopoietic stem and progenitor cells (HSPCs) encode trained immunity and differentiate into trained macrophages via IFN- $\gamma$  signaling. To learn more about the signaling pathways of trained immunity, we cultured then challenged macrophages derived from wild-type and IFN- $\gamma$  receptor 1 knockout (IFN- $\gamma$ R1 KO) mice using a *Mycobacterium avium* (*M. avium*) killing assay. Additionally, we challenged macrophages derived from untrained and trained mice with GFP-labelled *M. avium* to determine if training leads to increased phagocytosis. Through our project, we intend to compare bacterial CFU/bacterial clearance amongst macrophages derived from wild-type and IFN- $\gamma$ R1 KO mice, in addition to comparing phagocytosis rates between macrophages derived from trained and untrained mice. These findings will further our understanding of trained immunity, which can be used to develop infectious disease therapies or vaccines.

## **Drug-Antigen Combinations to Induce Tumor-Specific Immune Activation in a Local Cancer Vaccine Delivery Platform**

Nikitha Kota | Mentor: Corinne Ying Chua

Cancer vaccines aim to mount an anti-tumor response through prolonged immunomodulation. However, effective cancer vaccine delivery to generate a potent anti-tumor response is challenging. To overcome this obstacle, we developed the NanoLymph, a vaccine platform that triggers immune activation through continuous delivery of immune adjuvants and cancer antigens to locally recruited dendritic cells. This targeted delivery platform alleviates the toxicities associated with systemic drug delivery. To establish a clinical relevance for this device, we applied a mixed lymphocyte approach to identify triple-negative breast cancer and melanoma tumor-associated antigen epitopes that promote T-cell responses. We activated dendritic cells with either irradiated tumor cells (4T1 or B16) or tumor-associated antigens (TRP-2, LyP-1, AH1, or Kp-10). Thereafter, consequent T-cell activation is analyzed through proliferation studies and antigen-specificity is determined via flow cytometry. These results will guide the selection of promising cancer antigen and adjuvant combinations to apply in the NanoLymph, with the goal of promoting a clinically relevant immune response towards 4T1 and B16 tumors.

## **Cyclophilin A Chaperone Role in Phase Separation and Hematopoietic Stem Cell Aging**

Charles Lee | Mentor: Andre Catic

Proteostasis entails a delicate balance between cellular pathways of protein synthesis, folding, and degradation. For hematopoietic stem cells (HSCs), maintaining proteostasis is essential for the long-term production of erythrocytes and immune cells, as well as the efficacy of stress responses through a long cellular lifespan. However, the specific mechanisms of proteostatic imbalance involved in HSC aging are unclear. Cyclophilin A, or peptidyl-prolyl cis-trans isomerase A (PPIA) is a ubiquitous chaperone. Many of the

proteins that PPIA interacts with in the cytosol of HSCs are intrinsically disordered proteins, some of which are involved in phase-phase separation. Phase-phase separation drives the division of the cytosol into multiple immiscible regions, and consequently the formation of membrane-less organelles such as stress granules. In this project, we identified an impairment to phase separation associated with PPIA knockdown. Thus, PPIA may play a role in stress granule formation and proteostasis in the larger context of the hematopoietic stem cell aging process.

## **Group-Size Preferences in *Drosophila Melanogaster* in Do Not Change in Response to Selection Pressure Exerted by Evolutionary Traps**

Caroline Leung | Mentor: Julia Saltz

The speed at which anthropological disturbances are changing the world can lead to the uncoupling of environmental cues and their associated adaptive behaviors. A maladaptive response to an ecological stimulus due to human environmental disturbances has been termed an evolutionary trap. However, understanding the social contexts in which these traps are presented and how they can impact susceptibility remains an important challenge. Here, we performed artificial evolution for behavioral responses in the model organism *Drosophila melanogaster* over twenty-two generations. We investigated whether selection pertaining to olfactory-guided behavior would influence group size preferences in food patch use. We found that group size preference did not change in populations experiencing selective pressure via the evolutionary trap. It is yet to be determined if RNA sequencing will reveal changes in chemosensory gene expression or other genetic changes associated with artificial evolution.

## **The Effect of Lifespan-Extending Gene Expression in Neuronal Subtypes**

Daniel Li | Mentor: Juan Botas

The average age in America is on the rise, along with neurodegenerative diseases. However, populations with greater than average lifespans generally experience delays in neurodegeneration and an improvement in health outcomes, a key observation for understanding how to reverse neurodegenerative diseases. I hypothesize that modifying genes known to suppress neurodegeneration in different neuron populations will improve normal brain health with age. I will manipulate expression of candidate genes in neuronal subtypes using (*Drosophila melanogaster* models), and use high throughput behavioral assays to analyze the health and the lifespan of my models over 60 days. To control for the possibility that the tested alleles might modify the binary expression system used to generate mutant fly lines, I will use western blotting to confirm the validity of results. Finally, I will use electroretinograms for certain genetic variants to further analyze neuronal health. This analysis will be insightful in understanding how genes known to protect the brain during disease can also improve brain health during normal aging, and whether this effect is controlled by specific neuronal subtypes.

## **Discovery and Characterization of Novel Bacterial Biosensors in the Human Gut Microbiome via Genomic Sequence Features**

Hannah Li | Mentor: Kevin Lorch

The human gut microbiome harbors a diverse array of bacteria that regulate human health. Two-component systems (TCSs) are a ubiquitous family of signal transduction systems in bacteria and are the primary method bacteria use to sense and respond to stimuli in their environment. However, the majority of TCSs in the human gut microbiome sense unknown inputs. Through developing a robust discovery and characterization methodology, we aim to discover novel TCS biosensors that can be engineered into diagnostic microbes for gut diseases. The Tabor Lab has developed a next generation sequencing (NGS) screen to identify leads for novel TCS biosensors in high throughput. However, NGS may overlook potential TCS biosensors with low signal-to-noise ratios. Thus, I implement a rational screening method that uses TCS sensor domain sequence features and genes near TCSs in their native genomes to prioritize potential TCS-input pairs for screening, allowing for TCS-specific investigation. I then characterize the behavior of potential TCS biosensor systems through site-directed mutagenesis and dose-response experiments. Rational screening can be used with NGS as a novel, robust TCS biosensor discovery methodology.

## **The Effect of KDM4A Knockout on the Tumor Microenvironment of Neuroendocrine Prostate Cancer**

Derek Liang | Mentor: Guocan Wang

Neuroendocrine prostate cancer (NEPC) can develop from prostate adenocarcinoma treated with androgen receptor (AR) pathway inhibitors and is the most lethal type of prostate cancer. The median survival for patients with prostate adenocarcinoma ranges from 14 to 32 months whereas NEPC has a much shorter median survival of around 7 months. The tumor microenvironment (TME) plays a major role in prostate cancer progression and has yet to be characterized for NEPC. Thus, a better characterization of TME in NEPC may lead to better therapeutic strategy in NEPC. Kdm4a is overexpressed in NEPC and genetic deletion of KDM4A in TRAMP mice, a lethal prostate cancer mouse model, has resulted in a delayed tumor expression as well as extended survival. However, the impact of KDM4A knockout (KO) is not yet clear. To better characterize the effects of KDM4A on NEPC TME, we performed immunohistochemistry (IHC) staining for common immune cells in mouse and human adenocarcinoma NEPC tumor samples. We analyzed the stained slides using QuPath, and found that the TRAMP/KDM4A KO samples had a lower immune cell presence than samples from TRAMP mice, suggesting that KDM4A KO leads to a colder TME.

## **All eyes on me: Exploring the Impact of Eavesdropping on Social Information Transmission in *D. melanogaster*.**

Jasmine Liew | Mentor: Marina Hutchins

Individuals can gain information about their environment by observing the actions of others. Territoriality, where an individual occupies a defended area or resource, is a potential source of social information in *D. melanogaster*. Here, we consider how an eavesdropper changes their behavior after watching an aggressive encounter between two males. We accomplish this by setting up a 2-period contest. In the 1st period, we place



two males into an arena with a food patch while a male eavesdropper watches the encounter. We then measure the aggressive and territorial behaviors displayed by the individuals throughout a 30-minute contest. In the 2nd period, we place the eavesdropper into the arena with the two males that it was observing. We then record which individual the eavesdropper attacks more and analyze if the eavesdropper's choice is related to the behaviors it observed in period 1. Pending results may bring insight into the impact of the audience effect on territorial behavior, and further research into this field may help us discover how social information use can lead to the development of novel behavioral patterns in evolutionary biology.

### **Direct formation and site-selective elaboration of methionine sulfoximine in polypeptides**

Alex Lin | Mentor: Zachary Ball

Post-translational modification of peptides and proteins has become a highly studied area with diverse applications to chemical biology, medicinal chemistry, and many other fields. Useful modification methods must be selective for certain amino acid side chains and allow the possibility of installing a reactive handle for more complicated secondary bioconjugation. In particular, methionine has a unique thioether group that can be exploited through various reactions. However, the bulk of reported methionine modifications rely on simple alkylation of its thioether with alkyl halides, epoxides, etc, while modifications based on sulfur redox chemistry have been largely unexplored. Recognizing this deficiency, we report the oxidation of the methionine thioether to methionine sulfoximine (MSO) within polypeptides using a hypervalent iodine reagent. MSO is subsequently shown to be a competent bioorthogonal reactive handle in a Chan-Lam coupling with aryl boronic acids. Furthermore, several of our MSO-containing polypeptides show significant inhibition of glutamine synthetase, suggesting a broader application of this work for the inhibition of ATP-dependent carboxylate-amine ligases.

### **Increasing *Symbiodinium* Thermotolerance through Transgene Insertion with RAD51 Transient Transfection**

James Liu | Mentor: James Liu

This study aims to genetically engineer coral symbionts, *Symbiodinium*, to be more thermotolerant by increasing their antioxidant capacity. To achieve this goal, we are developing a CRISPR/Cas9 genome editing system to insert a hyperactive gene encoding the oxidant-consuming enzyme ascorbate peroxidase (APX). In this process, expression of Cas9 plus a guide RNA cuts the *Symbiodinium* genome and the APX is inserted via homologous recombination. To favor the latter reaction over the competing NHEJ DNA repair system where DNA insertion does not occur, I designed and constructed a RAD51 transient transfection plasmid to increase the rate of homologous directed recombination. Transformation of *Symbiodinium* will be performed to allow transient expression of RAD51 to promote insertion of APX DNA. I intend to compare transformation rates of the APX transgene with and without the transient transfection plasmid for RAD51 expression. Results will show the effects of RAD51 transient transfection on the incorporation of exogenous DNA into the *Symbiodinium* genome. If successful, this project will be one of the first to transform *Symbiodinium* with a transgene.

## **Role of SETDB1 in Safeguarding Adult Stem Cells Against ERVs in Aging**

Virginia Liu | Mentor: Virginia Liu

Much of a mammalian genome constitutes of repeats, where transposons make up a major class. Most transposons located in the heterochromatin are constitutively repressed in adult somatic tissues. SETDB1 is a histone methyltransferase that catalyzes the tri-methylation of histone 3 lysine 9 (H3K9me3). Loss of SETDB1 has been shown to cause gene instability with decrease in H3K9me3 and consequent activation of endogenous retroviruses (ERVs), a major class of transposons. Previous findings have shown that genome wide reactivation of ERVs can affect somatic tissues and cause diseases, such as in the gut epithelial and B cells. Using skin as our model, our lab set out to examine SETDB1 function in safeguarding adult stem cells against ERVs in aging. My research primarily involves using bioinformatics analysis to better our understanding of SETDB1's role across different organs and cell types. In hair follicle stem cells, SETDB1 is induced and declines during aging. Loss of SETDB1 resulted in continuous hair growth cycle and pre-mature aging with loss of H3K9 tri-methylation and de-repression of ERVs. Our results suggest that SETDB1 erosion results in endogenous retrovirus in aging.

## **Synthesis of $\alpha$ -Bromo *N*-Alkoxy and *N*-Aryloxy $\beta$ -Lactams from $\alpha,\beta$ -Unsaturated Silyl-Imino Ethers**

Pierre Loch-Temzelides | Mentor: László Kürti

Much of a mammalian genome constitutes of repeats, where transposons make up a major class. Most transposons located in the heterochromatin are constitutively repressed in adult somatic tissues. SETDB1 is a histone methyltransferase that catalyzes the tri-methylation of histone 3 lysine 9 (H3K9me3). Loss of SETDB1 has been shown to cause gene instability with decrease in H3K9me3 and consequent activation of endogenous retroviruses (ERVs), a major class of transposons. Previous findings have shown that genome wide reactivation of ERVs can affect somatic tissues and cause diseases, such as in the gut epithelial and B cells. Using skin as our model, our lab set out to examine SETDB1 function in safeguarding adult stem cells against ERVs in aging. My research primarily involves using bioinformatics analysis to better our understanding of SETDB1's role across different organs and cell types. In hair follicle stem cells, SETDB1 is induced and declines during aging. Loss of SETDB1 resulted in continuous hair growth cycle and pre-mature aging with loss of H3K9 tri-methylation and de-repression of ERVs. Our results suggest that SETDB1 erosion results in endogenous retrovirus in aging.

## **The Role of Let-7 MicroRNA in Interstitial Lung Disease**

Shivani Lotlikar | Mentor: Matthew Seasock

Idiopathic pulmonary fibrosis (IPF) is a chronic condition of the lungs characterized by scarring of the interstitium of the lungs. Current literature indicates that the dysfunction of the epithelial progenitor stem cell, alveolar type 2 (AT2) cells, may play a role in the progression of IPF. Specifically, patients with IPF have been found to have an accumulation of AT2 cells with dysfunctional mitochondria, impaired metabolic processes, and a senescence-like cellular phenotype. Two clusters of the let-7 family, a critical factor involved in the formation of inflammation and cellular senescence, have also been found to be downregulated in patients with IPF. Thus, this study aimed to

determine the mechanisms by which the downregulation of the let-7afd and let-7bc clusters led to the formation of AT2 dysregulation. Let-7 deletion mice were assessed as models of IPF by quantifying fibrosis in the lungs and analyzing lung functioning. It was found that let-7afd deletion in mice led to the spontaneous development of fibrosis and decreased lung functioning. Moreover, DNA damage and hyperproliferation of AT2 cells were analyzed and found to increase due to let-7afd deletion.

## **Interactions between Representations in Vibrotactile Working Memory**

Radha Malhotra | Mentor: Jeffrey Yau

In the past, many working memory (WM) theories assumed that during maintenance, representations of information existed independently. However, recent research in visual WM has suggested that representations do interact. We used a retro-cue design and delivered different stimuli to each hand to test whether representations in vibrotactile WM (vtWM) interact across hemispheres. Subjects were sequentially presented with 1-2 unimanual test vibrations on separate hands, a cue, and a bimanual probe vibration. Then, they were asked whether the probe or cued test vibration had a higher frequency. There were 3 conditions: 'Control' when only 1 test vibration is delivered, 'Congruent' when the probe frequency is higher or lower than both test frequencies, and 'Incongruent' when the probe frequency is in between both test frequencies. We hypothesized that vtWM representations from the hands do interact with each other and expected the relative frequency of the vibration on the non-cued hand to impact performance. The results did support our hypothesis as frequency discrimination performance was higher in the Congruent condition and lower in the Incongruent condition when compared to Control.

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## **Expressing and Purifying Stable *Colletotrichum camelliae* Filamentous Virus 1 (CcFV-1) Proteins for Structural Analysis**

Pranav Mandyam | Mentor: Yu Ouyang

The vast majority of double-stranded RNA (dsRNA) viruses have icosahedral capsids to efficiently transcribe and replicate their RNA genomes within the capsid. However, the discovery of a filamentous dsRNA virus, *Colletotrichum camelliae* Filamentous Virus 1 (CcFV-1), challenges this evolutionary trend. Studying the structure and function of the CcFV-1 transcription/replication complex would address how the transcription and replication of CcFV-1 differ from typical dsRNA viruses. In order to resolve the structure of CcFV-1 P1 (RNA-dependent RNA Polymerase, i.e., RdRP), various expression and purification assays were conducted to obtain the stable RdRP in high quality and quantity. Eventually, an N-terminally truncated P1 ( $\Delta 85$ ) was purified as monomers with a stable high yield. In addition, the full-length P1 and the predicted methyltransferase P3 co-eluted as complexes, indicating direct protein-protein interactions. Further structural prediction analysis of all CcFV-1 proteins indicated that P2 is likely to be the other methyltransferase, suggesting that P1, P2, and P3 may form a heterotrimeric polymerase complex, similar to members in the *Reoviridae* family.

## **The *BRAFV600E* Oncogene is a Sufficient Driver of Tumorigenesis in Human Cerebral Organoids**

Sujay Marisetty | Mentor: Luigi Perelli

*BRAFV600E* is a prevalent mutation occurring across various CNS tumors, including gliomas. Recent clinical trials demonstrated the safety and efficacy of BRAF inhibitors (BRAFi) in treating gliomas. However, treatment-resistant glioma cells challenge the therapeutic value of BRAFi. Therefore, to understand the molecular mechanisms driving resistance, we genetically engineered human induced pluripotent stem cell-derived cerebral organoids to express the *BRAFV600E* oncogene and a GFP reporter. *BRAFV600E* overexpression led to expansion of GFP+ cells distributed throughout the cerebral organoids. Additionally, the *BRAFV600E*-mutant genetically engineered cerebral organoids (GECOs) were implanted subcutaneously in immunodeficient mice to demonstrate tumorigenesis in vivo. Histological characterization revealed a mixture of proliferating clusters of *BRAFV600E* mutant glial cells - including astrocytes and oligodendrocytes - which suggests that the *BRAFV600E* is a sufficient driver for the formation of tumors with glial-like morphology. Moving forward, we anticipate screening BRAFi-treated *BRAFV600E*-mutant GECOs to unravel molecular alterations of resistant tumors.

## **Determining substrate utilization profiles of Clade 5 *Clostridioides difficile***

Nathanael Mathew | Mentor: Nathanael Mathew

*Clostridioides difficile* is a spore-forming, Gram-positive bacteria that is the cause for the most hospital acquired infections in the United States. The addition of the dietary sugar trehalose into the food system is correlated with the rise of certain epidemic ribotypes (i.e., subgroups) of *C. difficile*. Given the importance of carbon metabolism on the growth of *C. difficile* ribotypes, studying how emerging ribotypes utilize common dietary substrates will provide insight into *C. difficile* pathogenesis and transmission.

Preliminary evidence suggests that animal-associated Clade 5 *C. difficile* ribotypes can better utilize simple sugars than human-associated ribotypes. Therefore, we compared the growth of different *C. difficile* isolates by growing them in minimal media supplemented with different carbon substrates. Overall, we found Clade 5 isolates can robustly utilize tagatose and other simple sugars, with slight differences in growth between animal-associated and human-associated Clade 5 isolates. Ongoing work will further explore these results through competition growth assays.

## **Determining phenotypical differences among mitochondria of PDAC**

Nafiza Meher | Mentor: Taniguchi Cullen

Pancreatic ductal adenocarcinoma (PDAC) mitochondria are possible targets for treatment due to the role they play in adaptation to the hypoxic environment. Past studies showed PDAC mitochondria have changes in the oxidative phosphorylation pathway and unique morphology, like abnormal fragmentation. Research with mouse models in the lab found that inducing mitochondria fusion can lead to mitophagy and thus improved survival. While results were promising, we still lack a full understanding of PDAC mitochondria phenotype. To alleviate the gap, machine learning intelligence can allow for the analysis and comparison of mitochondrial phenotypes from a large variety of samples. To do this, patient PDAC tissue was sectioned and imaged using automotive serial electron microscopy for high-resolution data. Then, the data was annotated over an x, y, and z plane for examination of size, shape, and volume (morphological characteristics) for the purpose of training a machine learning program. The program allows for the automatic collection of data from a large variety of PDAC samples, stroma samples, etc. The analysis will pave the way for future considerations for therapeutics.

## **Integrating AWS for development of an efficient pipeline for RNA-sequencing alignment and analysis**

Suchir Misra | Mentor: Isaac Hilton

RNA-sequencing is the preferred method for transcriptome analysis due to its higher resolution and lower variability when compared to DNA microarrays. Analysis of RNA sequencing proceeds in multiple steps, including sequence alignment, counting, normalization, and differential expression analysis, and thus could benefit from extensive automation. Existing automated pipelines for RNA-sequencing analysis require the use of computers with high RAM and storage capabilities. Amazon Web Services (AWS) can be used to bypass these computational constraints. This study aimed to improve on existing pipelines by leveraging the use of AWS to fully automate RNA-sequencing analysis. The STAR aligner, feature Counts, and DESeq2 were used to conduct sequence alignment, sequence counting and normalization, and differential expression analysis respectively. The AWS pipeline analyzes sequencing data quickly and more efficiently than the same pipeline without the use of AWS would. The pipeline also returns expected sequence counts and differential expression analysis and can serve as a starting point for more accessible RNA-sequencing analysis pipelines.

## **The Function of Receptors CXCR2 and CXCR4 in NEPC Metastasis**

Jane Mo | Mentor: Ming Zhu

It was reported that CXCR2 and CXCR4 have a key function in NEPC metastasis. To better understand the role of CXCR2 and CXCR4 in NEPC, we will determine their function. I performed cell migration and invasion assays and found that the CXCR2's cytokine CXCL8 and CXCR4's cytokine CXCL12 increase the NEPC cell migration and invasion in vitro. Based on the cytokine's effect, I then added CXCR2's inhibitor SX-682 and CXCR4's inhibitor WZ811 in a separate migration and invasion assay and found that they blocked migration and invasion. Meanwhile, we will test the expression of receptors including CXCR2 and CXCR4 in both human and mouse prostate cancer lines by qPCR and perform siRNA knockdown (KD) to elucidate the mechanism of the receptors CXCR2 and CXCR4 in NEPC metastasis. To further confirm our hypothesis and its translation to clinical applications, we will then perform in vivo assays. First, we will label BPPR21798 with luciferase and inject them through the tail vein of mice to look at metastasis in vivo. We will use inhibitor treatment, knockdown of receptors, and existing chemo drugs for NEPC in different combinations as well as separately to look at their effect on metastasis.

## **Construction of Artificial Minicircles for Genetic Transformation of the *Cladocodium goreau* Chloroplast**

Audrey Moehring | Mentor: Michael Gustin

Rising global temperatures have led to an increase in mass coral bleaching events in which the loss of endosymbiotic algae from the coral host results in coral death. Evidence suggests that loss of this endosymbiotic algae may be due to accumulation of reactive oxygen species (ROS) within the algal chloroplast under heat stress. To test this hypothesis, we are working to genetically transform the chloroplast of *Cladocodium goreau*, a common algal endosymbiont of coral, to achieve expression of an ascorbate peroxidase (APX) enzyme. We hypothesize that expression of APX in the algal chloroplast will mitigate the effects of excess ROS production under heat stress and thereby increase coral thermotolerance. However, genetic transformation of *C. goreau* has not yet been achieved, and complexities of the *C. goreau* chloroplast genome pose unique challenges to recombinant DNA methods. Here, we report progress toward construction of an artificial *C. goreau* minicircle containing a chloramphenicol acetyltransferase gene in place of the native coding region to act as a selectable marker for genetic transformation.

## **Site-Directed Mutagenesis and Expression of MTHFD2L-G161E Plasmid DNA in *Escherichia coli***

Pratyush Mohaptra | Mentor: John Steele

The enzyme MTHFD2L (NAD-dependent methylenetetrahydrofolate dehydrogenase 2-like protein) carries out dehydrogenation reactions to oxidize THF-carbon units into formase during the folic acid cycle, allowing reduction of folate for mitochondrial and single-carbon metabolism to prevent neural tube defects (NTDs). A variant of the protein with Gly-161 mutated into Glu-161 occurred in three separate instances of a recently-sequenced cohort of 199 human NTD cases. Therefore, it was hypothesized that this single nucleotide polymorphism causes a decrease in functionality of MTHFD2L. To investigate this, a mutant MTHFD2L-G161E plasmid was created by transforming the plasmid into

*E. coli*, extracting copies of the plasmid, performing site-directed mutagenesis with mutant primers, and transformation/extraction of the mutant plasmid DNA. Subsequently, PCR was performed to confirm the desired mutation via sequencing, and restriction enzyme digestion (Bsp1 and Bfa1) was performed to confirm the plasmid map. Further research will center around growing the protein in CHO cells and performing biochemical assays to see if the G161E mutant has altered enzymatic activity compared to the wild type.

## **Wild-Type and Mutant *Candida albicans* biofilm development and hyphal-yeast transitions are temporally affected by Rapamycin**

Raul Montes | Mentor: Michael Gustin

*Candida albicans* is the most common cause of yeast infections in humans. If left untreated, infections have the potential to become hyper-aggressive and lethal. Hyphal-to-yeast transition points can regulate the virulence level in *C. albicans* infections as the dispersed yeast form spreads the infection throughout the bloodstream. Keeping *C. albicans* in hyphal form can help mitigate the onset of widespread infection. Rapamycin, an inhibitor of the TOR1 pathway, affects biofilm density. The DOT6 gene creates a spider biofilm, however, further information about morphological differences or dispersive yeast virulence is unknown. Genetic editing using CRISPR-Cas9 is being done for the DOT6 gene and will be done with PES1, a gene involved in *C. albicans* lethality, and YTM1, a gene in the TOR1 pathway. In vitro *C. albicans* biofilm growth is optimally grown in stationary conditions using RPMI as media. The usage of artificial saliva in biofilm growth is a viable option for increasing biofilm strength in vitro.

## **Characterization of Fluorescent Metal Complex Confinement within Boron Nitride Nanotubes**

Riaz Mowzoon-Mogharrabi | Mentor: Cecilia Martinez-Jimenez

Boron nitride has become an infamous material given its unique chemical inertness, insulative electronic properties, and extreme light weight, and in particular, boron nitride nanotubes have come into the limelight recently as an insulative counterpart to carbon nanotubes. However, the number of studies examining the use of the nanotubes' cavities for confinement is limited, and much work involving them remains theoretical. Here, we examine confinement of fluorescent ruthenium and rhenium metal complexes into the nanotubes via reflux, examining the effects of confinement procedure and choice of solvent on confinement favorability to take advantage of the nanotubes' lack of absorbance and emission in the visible spectrum. Inductively coupled plasma mass spectrometry confirms and quantifies the presence of the metal complexes within the nanotubes, and UV-Vis absorbance and fluorescence emission spectroscopy data, in both the solid state and in organic dispersions, show a distinct dependence on complex solubility as well as concentration, and suggest successful confinement in the wake of unique peaks when compared to hexagonal boron nitride controls.

## **Spatial regulation of hox gene signatures required for enteric neuron differentiation in zebrafish**

Nikhita Mummaneni | Mentor: Rodrigo Moreno-Campos

The enteric nervous system (ENS) is responsible for functions of the gut, including water balance and hormone secretions. These important bodily functions are hindered in diseases of the ENS. Therefore, it is important to understand the process of enteric neuron differentiation from enteric neuron progenitors (ENPs). Specifically, migratory enteric neural crest cells (NCCs) give rise to ENPs, and these ENPs differentiate into neurons and glia that make up the mature ENS. The genetic mechanisms that regulate enteric NCCs as they migrate and differentiate is not well understood. Published zebrafish NCC scRNA seq datasets in our lab has revealed hox gene signatures, like *hoxb5b*, in the ENS, but the precise gut spatial gene regulation is still unknown. To investigate these research questions, we used cryo-sectioned zebrafish embryos and used multiplexed HCR to visualize gene expression in situ. Alongside, with the computational tools Fiji-Labkit, Imaris, and Giotto, we performed Spatial Genomic Analysis to analyze transcriptional signatures at single cell resolution. We found differential spatial expression of the gene *Hoxb5b* along the gut in ENPs.

## **MYCN Overexpression Expands Neural Crest Signature in Developing Sympathoadrenal Progenitors**

Annika Nambiar | Mentor: Rosa Uribe

Neuroblastoma (NB) is a deadly pediatric cancer that originates from neural crest cells (NCC) and presents tumors along the sympathetic nervous system, specifically in adrenal medulla and sympathetic ganglion chain. One genetic factor identified as a major driver of NB is MYCN, which is linked to high risk, aggressive tumors. It is believed that NB develops when NCC are unable to differentiate; however, the exact mechanisms behind early onset of NB remain unknown. To analyze if MYCN overexpression affects sympathetic cell differentiation from the NCC, in a zebrafish model, we used whole-mount immuno-coupled hybridization chain reaction (WICHCR) on zebrafish embryos across stages to assay gene expression of NCC and sympathetic gene markers like *crestin*, *foxd3*, *sox10*, *dbh*, and *phox2bb*. Our preliminary results show that MYCN overexpression induces cells to maintain an undifferentiated state by promoting retained expression of NCC genes past their normal time of expression. Overall, this study will help identify the effect MYCN overexpression has on early NCC differentiation and advance the field by listing potential candidates for drug targeting to develop more efficient therapeutics.



## **Repurposing FDA-Approved Drug to Overcome CDK4/6 Inhibitor Resistance in ER Positive Breast Cancer**

Nayna Nambiar | Mentor: Prasanna Alluri

ER positive breast cancer is the most prevalent type of breast cancer with every  $\frac{2}{3}$  new case being diagnosed as this type of breast cancer. CDK4/6 inhibitors are the main treatment for ER positive breast cancer. However, we see that patients have become resistant to these treatments. The mechanism of resistance that we are specifically focused on is CDK6 overexpression. Palbociclib is a common FDA-approved CDK4/6 inhibitor used to treat patients. We introduced a green fluorescent dye to a population of CDK6 OE cells and red fluorescent dye into the wild-type cells. Our plan is to mix these two cells together and screen against a large panel of drugs to identify drugs that specifically target resistant cells. To prepare for the screen, we mixed wild-type and CDK6 OE cells in 3:1 ratio where the amount of wild-type cells were higher, plated the mixture in a 6 well plate, and treated them with DMSO, Palbociclib, and 1-184. Based on our findings, we can conclude that CDK6 OE shows resistance to palbociclib models in ER positive breast cancer and that fluorescence labeling in resistant cells and WT cells enable high output drug screens to identify novel drugs to overcome resistance.

## **Impact of Biopolymer on Macrophage Behavior in Inflammatory Models**

Adam Nelson | Mentor: Crystal Shin

Wound healing is a complex process mediated by several pathways in the immune system. Disruptions in these pathways can perpetuate inflammation and stall healthy wound resolution. A number of clinical treatments are available for overactive inflammation. However, these systemic treatments are often associated with adverse effects under high-dose and high-frequency regimens. Therefore, a locally-applied therapy is ideal for the more precise treatment of non-healing, chronic wounds. We have previously documented the pro-inflammatory cytokine capture properties of PVA STMP-based hernia meshes in vivo and aim to utilize this property to modulate local inflammation. Macrophages are important immune cells responsible for perpetuating inflammation and organizing wound healing. Preliminary experiments have shown that the PVA STMP biopolymer has a beneficial impact on the morphology ratio in vitro likely related to its cytokine capture abilities. In this project, we investigated the impact of PVA STMP on macrophage behavior in inflammatory models, analyzing macrophage polarization and inflammation propagation through the wound healing process in response to biopolymer treatment.

## **Cooperative Earth-Abundant Element Catalysis Enables New Approaches to Anti-Markovnikov Hydrochlorination and Trifluoromethylation**

David Nemoto | Mentor: Julian West

Progress in transition metal catalysis in recent years has allowed for countless new reactions vital to unlocking new medicinal and bioactive compounds. Earth-abundant iron catalysis enables these chemical transformations to be environmentally sustainable. Developments in iron photoredox catalysis have unlocked two difficult, expensive, and elusive transformations: anti-Markovnikov hydrochlorination and hydrofluoroalkylation. These transformations are proposed to occur through ligand-to-metal charge transfer (LMCT) followed by a hydrogen atom transfer (HAT) enabled by dually catalytic thiols. Redox neutral iron-thiol dual catalysis renders a cheap and practical system for functionalizing unactivated alkenes. This system allows for the unprecedented use of chloride in the absence of acid to yield exclusive anti-Markovnikov hydrochlorination as well as the use of cheap trifluoroacetic acid to enable a direct decarboxylative approach to trifluoromethylation. The scope of these transformations is broad and includes the successful transformation of pharmaceutical and natural product derivatives. Mechanistic studies provide further evidence of the LMCT/HAT radical pathway proposed.

## **Parental Factors Influencing Pre-Adolescent Self-Efficacy for Physical Activity**

Cecile Nguyen, Esteban Pantoja, Aditi Velgekar | Mentor: Cassandra Diep

Less than 1 in 5 adolescents and 1 in 4 adults in the U.S. meet the recommended physical activity guidelines (Friel et al. 2020). SES and family environment have long been demonstrated to be important predictors of physical activity in childhood (Sallis et al. 1992, Tandon et al. 2012). Importantly, childhood trends in physical activity at times carry into adulthood, making this life period a critical one for physical activity promotion (Telama et al. 2005). The mobilization of families for physical activity promotion is therefore a promising approach to increasing lifelong physical activity, especially in low-SES communities. This study uses survey data to describe how nonmaterial support and modeling of physical activity by a parental figure influences pre-adolescent (ages 8-12) self-efficacy for physical activity using survey data. Family participants were recruited from an after-school program for at-risk youth in Houston, Texas. Our results provide insight into how pre-adolescent physical activity interventions can be most effective within and outside this sample population.

## **Engineered, Single-Copy Novel Phosphorylation Circuits in Mammalian Cells**

Jaison Nguyen | Mentor: Xiaoyu Yang

Phosphorylation is the most common form of information transfer in cellular signaling networks to relay changes in the external and internal environment. Engineered synthetic phosphorylation-based circuitry holds promise for the modification of the endogenous response of mammalian cells. However, the commonly used method for studying these systems in cells, namely transient transfection, lacks the ability to provide tight and tunable expression of protein products. Here we use hierarchical Golden Gate cloning to assemble plasmids that can be integrated into a genetic landing pad site at the AAVS1 locus of HEK293T cells via a recombinase. This utilization of a single-copy integration allows for stable expression of engineered phospho-signaling circuits, enhancing the predictive ability and capacity to model these novel systems.

## **Development and Application of an Ultra Photostable and Bright Yellow Fluorescent Protein**

Nathan Nguyen | Mentor: James Lee

Fluorescent proteins are widely utilized for biological research to visualize biological structures and processes such as gene expression, protein localization, cell shape, and cellular activity, to be visualized by microscopy. However, the current generation of fluorescent proteins suffers from low photostability, the progressive dimming of fluorescent proteins due to repeated or prolonged illumination of excitation light. Photolabile fluorescent proteins limit several critical experiments, such as single-molecule experiments with high illumination power and fast temporal imaging with continuous illumination. In particular, yellow fluorescent proteins, which are widely used as protein tags and within protein-based biosensors, greatly suffer from rapid photobleaching. To solve this problem, we conducted high-throughput directed evolution experiments and developed the most photostable fluorescent protein to date. Our mGold2 is 20-fold more photostable and as bright as other commonly used yellow fluorescent proteins such as mVenus, mCitrine, and YPet. We anticipate a wide utilization of mGold2 to visualize biological structures and processes that were previously difficult to study.

## **Mitochondrial Transcription Factor A (TFAM) Binding to Undamaged DNA vs. Abasic Sites in Light Strand Promoter (LSP) and Nonspecific DNA**

Tiffany Nguyen | Mentor: Rory Sharkey

Human cells undergo millions of mutations everyday, but most of the damaged nuclear DNA gets repaired to prevent errors during DNA replication. Mitochondrial DNA (mtDNA), however, is prone to a higher mutation rate than nuclear DNA because it lacks the organizational complexity and repair

mechanisms needed to protect its replication and transcription processes. Consequently, alterations in mtDNA can result in the development of mitochondrial disorders and other human diseases. Abasic sites are common endogenous DNA lesions in the cell that can arise from either base excision repair or spontaneous base loss, so when mtDNA is damaged, mtDNA degradation serves as an important quality control measure. Mitochondrial Transcription Factor A (TFAM) is a DNA-binding protein that plays an essential role in mtDNA packaging, replication, and transcription. Assessing the binding affinity of TFAM to abasic lesions in different DNA substrates will help provide insight into the signaling and repair pathways of these lesions in the mitochondria. To measure and compare the protein's binding affinity to both undamaged and damaged LSP and nonspecific DNA, electrophoretic mobility shift assay was used.

### **The Effect of Bone Morphogenic Protein Inhibition on Enteric Neural Crest Cell Proliferation and Maturation in Zebrafish 24-96 Hours Post Fertilization**

Arielle Noah | Mentor: Rosa Uribe

The vertebrate enteric nervous system (ENS) is a network of ganglia formed from enteric neural crest cells (ENCCs). ENCCs migrate from the foregut to the hindgut within the smooth muscle of the entire gut until neural crest cell (NCC) differentiation. Failure of ENCCs to form ENS can lead to poor gut health and diseases, like Hirschsprung disease (HSCR). HSCR human patient data shows that aganglionic gut has increased levels of Bone Morphogenic Protein (BMP) ligands; this indicates BMP signaling issues. In chicken, BMP signaling attenuation reduces the number and size of ENS ganglia in the developing gut. Yet, *in vivo* mechanisms are unclear. Zebrafish have conserved ENS development. The goal of this study is to find the times zebrafish require BMP to properly form gut ENS. In zebrafish, we discovered that using the inhibitor KO2288 during 24, 48, 72, and 96 hours post-fertilization, BMP attenuation reduced the number of enteric cells in the hindgut. I will perform immunohistochemistry to assay KO2288-treated transgenic zebrafish (*phox2bb: Kaede*) using primary antibodies to track both proliferation (PHH3) and maturation (HuC/D).

### **The Role of Genetic Variation in Social Information Production in *Drosophila melanogaster***

Sarita Palacio | Mentor: Julia Saltz

The relationship between environmental variation and social information production has been vastly studied. It is known that variations in environment can influence social behaviors, whether it may be in courting rituals, territoriality, or in social networks; however, there is a disconnect in the exploration of the influences of genetic variation in social behavior. To account for the role of genetics in social information production, we are conducting an experiment where we manipulate the social environment of male *Drosophila melanogaster* during their

social interactions. We tested three treatments: male observer, female observer, or no observer. In all treatments, we measure the aggressive behaviors between two male flies as a method of measuring social information production. While this experiment is ongoing, preliminary data demonstrated that some genotypes demonstrated higher levels of aggression. The results from this experiment can contribute to building a conceptual framework on how genetic variation influences behavior, which allows for a greater understanding of the implications of those factors on social behaviors.

### **Identification of BMP4 Dosage for Micropatterning of Human Embryonic Stem Cells to Identify Effects on Neurulation**

Ana Park | Mentor: Ye Zhu

Neurulation initiates the formation of the vertebrate brain and spinal cord and is coordinated and patterned by BMP and WNT signaling pathways. Studying neurulation is crucial in understanding and identifying the molecular basis of the central nervous system along with the pathogenesis of neural tube defects (Colas and Schoenwolf, 2001). The differentiation and distinction of non-neural and neural fates initiates the folding in neurulation, in which BMP signaling first triggers expression of this outer non-neural ectoderm (Britton et al., 2019). Thus, BMP signaling is a significant parameter to put into consideration before recreating the 3D model of neurulation. This experiment is a prerequisite for further testing on PAX3 knockout cells on micropatterning plates– the focus is to identify the optimal dosage of BMP4 that will be utilized in consequent ectoderm micropatterning experiments. The fates of these hESCs can be observed in detail when adhered to a micropatterned surface, thereby confining the growth to a specific self-organizing pattern. The broader objective of this experiment is to remodel the human neurulation process with PAX3 knockout cells in a 3D conformation.

### **Genome Mining of *Aspergillus* Fungus for the Discovery of RiPPs**

Riya Parmar | Mentor: Chunxiao Sun

Natural products have played an important role in advancing the pharmaceutical industry. Ribosomally synthesized and post-translationally modified peptides (RiPPs) are a group of natural products that are found in various organisms including plants, bacteria, and actinomycete, and thus have great potential in advancing medicine. However, these natural products are rarely seen activated in fungi, and the biosynthesis pathway is not fully understood. Nevertheless, bioinformatics indicate that RiPPs gene clusters are found in various *Aspergillus fungi*, but the genes are silent in vitro. In order to detect the biosynthesis pathway, the silent genes must be activated. Heterologous expression will be used to activate these silent gene clusters. The project will utilize plasmid construction through yeast assembly and *E. coli* transformation. The plasmid construction will then

undergo fungi transformation upon selection medium. The metabolics produced from the fungi will be analyzed through the HPLC. The increased metabolics production compared to the wild type fungi will show that silent genes were activated and can now undergo further studies.

### **Identification of a gene set that correlates with resistance to lysine-specific demethylase 1 (LSD1) inhibition in brain tumors**

Kareena Patel | Mentor: Joya Chandra

Lysine-specific demethylase 1 (LSD1) is an epigenetic regulator of neural stem cell proliferation and differentiation. It is found highly expressed in many cancers such as glioblastoma (GBM). LSD1 inhibitors inhibit demethylase activity and promote cell differentiation. Previous research in GBM found 5 genes that were related to LSD1 inhibitor resistance and could potentially predict response. The five genes are HKDC1, RAB3IL1, RAB39B, FTH1, and FAM213A and have a pro-tumorigenic role in other cancer types. Our goal was to create a GBM cell line resistant to LSD1 inhibition and assess the effect on the resistant related gene set. The resistant line was generated by treating GSC17 cells with increasing concentrations of GSK-LSD1 every week. We intend to compare the expression of the gene set in the GSC17s at baseline to the resistant GSC17 line by assessing the gene set via qPCR. We expect an upregulation of the genes in the resistant line. We will explore the individual and combined contributions of these genes to the sensitivity to LSD1 inhibitors. This will help us understand the mechanism of resistance to LSD1 inhibitors in glioblastoma and to design new treatment strategies.

### **Effect of Expression of SPO1 Genes 55-53 on Cell Division**

Vinay Pattalachinti | Mentor: Charles Stewart

When the bacteriophage SPO1 infects the bacterium *Bacillus subtilis*, it converts the host cell from a factory for making new bacteria into one for making new phage. This host-takeover is accomplished by the genes of SPO1's host-takeover module, which includes genes 55-53. Expression of genes 55-53 in an uninfected *B. subtilis* cell induces a potent bacteriostatic effect. Despite cell growth continuing when genes 55-53 are expressed, the number of viable host cells remains relatively constant, suggesting cell division inhibition. Micrographs support this, as *B. subtilis* cells expressing genes 55-53 were longer than control cells at all measured time points after induced expression. Moreover, the induced cells grew longer with time, but the uninduced did not. The inhibition of cell division did not prevent continued DNA replication and nucleoid segregation.

## **Determining the Relationship Between Enteric Neuron Differentiation and Expression of the Retinoic Acid Signaling Pathway**

Victoria Payne | Mentor: Rosa Uribe

The retinoic acid (RA) pathway aids stem cell proliferation to differentiation transitions, activating gene transcription to induce stem cells to neural type cells in different tissues. It is believed that enteric nervous system (ENS) development, intrinsically found along the gut, connects with the RA pathway. However, if ENS neurons are downstream effectors of RA receptors is unknown. This study investigates ENS development's relation to the RA signaling pathway, deciding if ENS differentiated neurons are downstream events of the RA pathway. To analyze if RA candidate markers co-localize with ENS neuron markers, we used Immunohistochemistry (IHC) on zebrafish embryos across various temporal phases to assay protein expression of the RA protein markers Aldh1a2, Crabp2a, Cyp26b1, and Meis2.1 along with the ENS neuron markers Elavl3/4, Phox2b, Vip, and NOS. We intend to compare markers by gaining qualitative data from confocal microscope images along the zebrafish gut, discerning if RA pathway members co-localize or do not co-localize with ENS differentiated neurons. These findings will give a better understanding as to if the RA pathway may regulate enteric neuron differentiations.

## **A cytokine-secreting bacterial microneedle patch to treat periodontitis**

Vedha Penmetcha | Mentor: Jeffrey Tabor

Periodontitis is characterized by gum inflammation, tartar buildup, and bacterial growth from periodontal pathogens. This chronic tissue inflammation can lead to alveolar bone loss and degradation of gingival tissue. Existing treatments such as surgery, scaling and root planing, and antibiotics are effective, but do not target the unbalanced inflammatory response in the oral microbiome or are needed in high dosages. Localized delivery of anti-inflammatory therapeutics could improve patient outcomes and minimize side effects. Our project intends to employ synthetic biology tools to develop genetically engineered bacteria as living therapeutics. These therapeutic bacteria can potentially increase therapy retention at the disease site and reduce the need for high dosages. Currently, we are working on engineering *Lactobacillus reuteri* to secrete anti-inflammatory biomolecules of therapeutic interest for periodontitis: IL-10, IL-12, and IL-7. The anti-inflammatory cytokines are expected to inhibit pro-inflammatory molecules reducing alveolar bone resorption and tissue damage. For future delivery, a microneedle patch can provide localized secretion in vivo to the mouse oral environment.

## **NMR Analysis of Compost for Carbon Permanence at Various Stages of Decomposition**

Kathryn Phung | Mentor: Bezaye Tessema

Carbon market initiatives began after the 1997 United Nations Kyoto Protocol, which aimed to decrease CO<sub>2</sub> emissions worldwide. Over the last two decades, as an increasing number of companies pledge to achieve carbon neutrality, demand for carbon credits has grown rapidly, spurring market interest in finding new credit practices. To determine whether compost programs could count as carbon credits in emerging carbon markets, we aimed to measure carbon retention in composts using NMR analysis. The NMR data will help us better understand the permanence of carbon-based compounds at different stages of the decomposition process in various compost samples collected from Houston, Texas. The results from these analyses will be used as evidence in a project about the potential economic role of composting programs in emerging carbon markets. In addition, the results will also be translated into a visual-storytelling format to relay the information to a broader audience.

## **Determining the Effects of *Mnemiopsis leidyi* Genes for Phenotype Rescue of *Drosophila melanogaster* Flight Muscles**

Nishita Prasad | Mentor: Kate Beckingham

Past research has explored a theory that ctenophores *Mnemiopsis leidyi* evolved independently from other organisms, rather than having common ancestors because they have many genes that are not expressed in other animals. However, there is a possibility that these genes are instead highly differentiated versions of the same genes from other organisms. This research aims to support this explanation by introducing ctenophore genes to *Drosophila melanogaster* with phenotypic rescue and examining the effects. Current experiments in phenotype rescue have been focused on the *Drosophila* TroponinI protein, which plays a role in fly muscle contraction. When TropI is knocked down, the resulting progeny is flightless, and the *Drosophila* longitudinal flight muscles (DLMs) are malformed. It is hypothesized that ctenophore TropI may recover the physical structure of DLMs, visualized with phalloidin staining and fluorescent microscopy. This research determines whether ctenophore TropI can be used as a homolog of *Drosophila* TropI, and lends itself to the overall question of whether the organisms evolved from a common ancestor.

## **Processes of Mullerian Duct Regression During Male Development**

Ariah Richards | Mentor: Rachel Mullen

The Mullerian Ducts (MD) is the precursor of the female reproductive tract organs. In males, bipotential gonads become testes and release Anti-Mullerian Hormone (AMH) which will eliminate the MD. Without AMH or testosterone in females, the MD persists. Understanding MD regression may provide insights into the genesis



of Differences in Sex Development. In mice, samples are collected at E13.5 and E14.5 to mark MD Development and the start of regression. To determine the cause of regression, 2 types of whole mount immunofluorescence were used and imaged on the confocal: Pax 2 (epithelial tissue marker) was used with Cleaved Caspase 3 (apoptotic marker) or Phospho-Histone H3 (proliferating cells marker). Wnt7aCre mice crossed with mTmg mice help to visualize regression with time-lapse imaging. After E14.5 in males, the MD begins to regress in three stages before they are eliminated: thinning, breaking, and contracting. Apoptosis is seen in the MD of male mice starting at E14.5. There is more apoptosis at E14.5 for males than females. Cellular behaviors and movements of the MD, observed by static and time-lapse imaging, during MD regression suggest biomechanical processes are involved.

### **Tawny Crazy Ants and their Microbial Symbiont Composition**

Benjamin Rosengard | Mentor: Benjamin Rosengard

Invasive species cause economic impacts, environmental harm, and harmful effects to animal health. The tawny crazy ant *Nylanderia fulva* originates from South America and have been reported in parts of the southeast United States. Currently, although the microbial composition of the tawny crazy ant is unknown, it is possible the microbial composition of these ants varies by geographic region and aligns with the population genetic structure in each state. Alternatively, as with select ant species, like leaf cutter ants and carpenter ants, it is possible that tawny crazy ants harbor an obligate symbiont or core microbiome. Reads generated from high throughput sequencing were analyzed using the Kraken and Dada2 pipelines to detect the ants' microbial composition. We hypothesized that the microbial profiles will be similar within geographic regions and different across states. Our preliminary results show a variety of microbial organisms present, including *Dictyostelium* and *Mycoplasma bovis*, both harmful pathogen to animals. Understanding the variety of microbial organisms in these invasive ants may provide management solutions and better inform their evolutionary ecology.

### **pH Responsive Self-Assembling Multidomain Peptide Hydrogels with Histidine Functionalized Cores**

Gabriel Saenz | Mentor: Jeffrey Hartgerink

Multidomain peptides (MDPs) are a category of self-assembling peptides that rely on the sequestering of hydrophobic interactions and back-bone hydrogen bonding networks to form versatile hydrogel nanofibers. They are of particular biomedical interest due to their biocompatibility, immunomodulation, injectability, and overall similarity to the extracellular matrix. MDP hydrogels are also characterized by their versatile amino acid building blocks which have been previously manipulated to satisfy specific physical needs. Herein, we report the substitution of histidine into canonically hydrophobic and hydrophilic residues to functionalize MDP hydrogels with pH sensitive characteristics. The effects of histidine

functionalization on secondary structure and rheological properties across a wide pH range is reported, as well as the possible introduction of esterase activity.

### **The Potential Alzheimer's Disease marker SMOC1 modulates survivorship in Drosophila**

Saathwik Saladi | Mentor: David Li-Kroeger

Alzheimer's Disease (AD) is a neurodegenerative disease that affects over 24 million people worldwide. Although the main pathological features of AD have been studied extensively, we have yet to discover a definitive cure. A major obstacle to solving AD remains a poor understanding of the underlying biology. To identify and characterize protein changes that occur in AD, our collaborators from Emory University performed mass spectrometry proteomic analysis on human brain tissue from over 2000 postmortem individuals and identified SMOC1 as a key protein potentially driving neurodegeneration. Here, we use *Drosophila melanogaster* to interrogate the function of the SMOC1 fly ortholog (dSMOC1) by characterizing the effects of loss of dSMOC1 function in fly AD models relative to wild-type conditions. We show that decreasing dSMOC1 levels exacerbates neurological defects when human tau is expressed in neurons in a fly model of AD. In addition, we find that flies homozygous for null alleles of dSMOC1 show decreased survival relative to controls. Taken together, the data suggest SMOC1 has some possible modulating role for neurodegeneration in the brain.

### **Effects of Estrogen-related Receptor Gamma Gene Therapy on PAD**

Addison Saley | Mentor: Vihang Narkar

Peripheral arterial disease (PAD) and critical limb ischemia (CLI) are cardiovascular complications that are associated with insufficient vascularization, oxidative metabolic dysfunction, and myopathy. Estrogen-related receptor gamma (ERR $\gamma$ ) has shown to increase oxidative metabolism and angiogenesis in previous transgenic overexpression studies in mice. This study seeks to determine if ERR $\gamma$  gene therapy via a Adeno-associated virus (AAV9) Essrg gene delivery vector in ischemic muscles can promote recovery. AAV9-Essrg increased ERR $\gamma$  protein expression, increased genes associated with angiogenesis and oxidation, increased capillary density and succinate dehydrogenase oxidative metabolic activity in skeletal muscles of mice. ERR $\gamma$  overexpression also increase neo-angiogenesis and revascularization as well as restoration of succinate dehydrogenase oxidative metabolic activity in ischemic skeletal muscle. These results demonstrate that intramuscular AAV9-Essrg delivery promotes ischemic recovery and could be a potential strategy for managing PAD/CLI.

## **Role of NIRs in Ameliorating ATXN2[108Q] Induced Retinal Degeneration and Motor Impairment in SCA2**

Khondker Salim | Mentor: Ismael Al-Ramahi

Spinocerebellar Ataxia Type 2 (SCA2) is a neurodegenerative disease caused by an expanded CAG repeat in the ATXN2 gene leading to deleterious protein aggregation. Other neurodegenerative diseases are also characterized by cytoplasmic aggregation of RNA-binding proteins like ATXN2. Recent research in this field has revealed the utility of nuclear import receptors (NIRs) in chaperoning the disaggregation of RNA-binding proteins in the cytoplasm and facilitating their transport in the nucleus, thereby mitigating disease phenotypes. Previous research has shown that nuclear localization of ATXN2 is not necessary for SCA2 pathology and ATXN2 inclusions are mainly cytoplasmic. Thus in the context of SCA2 pathology, the chaperoning activity of NIRs are more pertinent than their role in nucleocytoplasmic transport of proteins. While the interaction of NIRs and karyopherins have been studied for other RNA-binding proteins, the effect of NIRs in ameliorating SCA2 pathology caused by mutated ATXN2 gene is not well studied. Here, we show that the overexpression of NIRs ameliorates the motor impairment and retina degeneration phenotypes of *Drosophila* flies expressing ATXN2[108Q] in neurons.

## **Transcription Factors Associated with Embryonic Mandibular Condylar Cartilage (MCC) Development**

Madelynn Salinas | Mentor: Noriaki Ono

The proper development of the mandibular condylar cartilage (MCC), an essential component of the temporomandibular joint (TMJ), is critical for daily functions, which include eating and speaking. The mesenchymal progenitor cells of the MCC are organized into distinct layers during embryogenesis and their proliferation and differentiation are regulated by multiple components. Previous research by Ono & Ono Labs discovered the importance of parathyroid hormone-related protein (PTHrP) for SOX9 and RUNX2 transcription factor expression as well as their organizational expression in the MCC. Although these findings confirm some of the early steps for MCC development, it is not yet known how the phosphorylation of SOX9 is involved (P-SOX9) during formation or how conditional deletion of the SOX9 and RUNX2 transcription factors affect PTHrP expression. Understanding the mechanisms responsible for the regulation of cells in the MCC will set the foundation for TMJ disorder (TMJD) treatment and craniofacial reconstruction. Future treatment for either of these conditions can be used to prevent chronic pain, restore confidence, and increase the quality of life for those affected by TMJD.

## **Elucidating the Role of Leucine-Rich Glycoprotein-1 within Subarachnoid Hemorrhage Pathophysiology**

Bibek Samal | Mentor: Devin McBride

Subarachnoid hemorrhage (SAH) is a major clinical problem and induces deleterious aftereffects such as loss of consciousness, brain damage, and hydrocephalus by limiting the amount of cerebral blood flow. In investigating potential therapeutic targets for SAH, leucine-rich alpha-2 glycoprotein 1 (LRG1), has been shown to be an essential protein involved with the disease pathophysiology of many neurological and inflammatory diseases. Through preliminary review, LRG1 has been found to work as a vascular factor, disrupting the formation of vessels through various cellular interactions. Based on this, our work focuses on finding out the role of this protein as a potential biomarker for the disease and a potential area in which we can target therapies. Within this study, SAH was induced into mice via endovascular perforation. The concentrations of the glycoprotein LRG1 were then measured by using an ELISA on several endothelial cell lines extracted from the mice. A standard curve with a linear fit was created for each assay in order to deduce protein concentrations for each cell line and identify critical information about the levels of protein.

## **Combinatorial CRISPR-Cas9 Screens To Identify Synthetic Lethal Interactions in Colorectal Cancer Cell Lines**

Kaitlin Sanders | Mentor: John Paul Shen

Mutating two genes can give rise to phenotypes that are unlike those expected from a mutation in one gene alone, a phenomenon known as epistasis. Epistatic interactions between the mutated genes can drive tumorigenesis, however not much is known about the various interactions between commonly mutated oncogenes in colorectal cancer. This project utilizes the method from Shen et al., to perform a combinatorial CRISPR-Cas9 screen on the SW480 cell line, a KRAS-mutant CRC cell line. The screen uses a combinatorial guide RNA library to target all possible genetic interactions between 114 selected oncogenes, resulting in 6441 tested genetic interactions. By sequencing genomic DNA over various points in the screen, we will fit growth curves to the measured abundances of each library construct over time, and integrate data from the guide RNA constructs to derive a fitness score that will ultimately be used to score genetic interactions, where a negative genetic interaction score suggests synthetic lethality. This data can be used to identify therapeutically relevant interactions and produce chemotherapies to target them.

## **Developing a Sex-Sorter in *Drosophila melanogaster* With Genetic Engineering**

Anuska Santra | Mentor: Herman Dierick

Separating males from females for experiments with *Drosophila melanogaster* is normally done by sorting them under a microscope based on their morphological

differences. Sex-sorting through genetic engineering is possible by taking advantage of the splicing patterns that naturally occur in *Drosophila* during sex-determination and by inserting “sex-specific introns” into the coding regions of drug-resistance genes (PuroR and NeoR). When flies whose drug-resistance gene (one or the other) is expressed by the gender specific splicing of their introns are fed the antibiotic to which they are now resistant, they will outlive their non-resistant siblings. The aim of my research is to make this sex-sorting strategy simpler by placing drug resistance and drug sensitivity markers directly on the Y-chromosome. This strategy can then be used to select for males or counter select against males depending on the drug that is fed to the population. To make these drug resistant/sensitive males, I am using Crispr/Cas9 genome editing to introduce the markers in different regions of the chromosome. Here I present the result of my ongoing selection and counter selection Y chromosome transgenesis.

### **The Role of the Hippo Signaling Pathway in Cardiac Conduction System Regeneration**

Maham Sewani | Mentor: Jun Wang

The cardiac conduction system (CCS) comprises a group of tissues in the heart that carry out the electrical impulses necessary for a heartbeat. The Hippo signaling pathway, a kinase cascade, has been linked to various cardiac functions including homeostasis and regeneration; however, its role in the CCS is largely unknown. This research delves into the effect of the Lats1/2 kinase deletion and subsequent deactivation of the Hippo pathway on a CCS mouse injury model using Diphtheria toxin A (DTA), a toxicity protein that causes cell death. Effects were measured through heart weight, electrocardiography, and various staining methods. Overall, Lats1/2 deletion was found to rescue DTA-induced mice death. Lats1/2 deletion reduced cardiac arrhythmias and improved cardiac function, indicated by electrocardiography and echocardiography. Staining revealed that deleting Lats1/2 led to decreased fibrosis, increased cell proliferation, and decreased cell death in the sinoatrial node. These findings support the conclusion that blocking the Hippo pathway results in CCS regeneration. Characterizing the effects of the Lats1/2 deletion can potentially help develop treatments to CCS diseases.

### **Investigating the Function of PEX11 N-terminal Helices on Peroxisomal Intraluminal Vesicle Formation in Arabidopsis**

Nayeli Shad | Mentor: Bartel Bonnie

Peroxisomes are critical organelles in plants responsible for metabolic processes including fatty acid  $\beta$ -oxidation which enables early growth of germinating seedlings. Proteins called peroxins control the biogenesis and maintenance of peroxisomes, and mutations in peroxins can be lethal in plants and other eukaryotes. It has recently been elucidated that peroxisomes contain abundant inner membranes, coined intraluminal vesicles (ILVs), which have roles in lipid metabolism. In *Arabidopsis*, the transmembrane protein PEX11 has five homologs

reported to control the proliferation and division of peroxisomes. We hypothesize that ILV formation is influenced by several proteins including PEX11 isoforms. We designed a CRISPR-Cas9 multi-gRNA strategy to knockout all PEX11 genes in Arabidopsis and determine if null mutants contain defects in ILV formation. We have found that ((pex11a pex11b)) double mutants display enlarged peroxisomes and almost entirely lack ILVs. Currently, we are investigating how several N-terminal helices influence the formation of ILVs.

### **Investigating the Role of G-Quadruplexes in Aging and Alzheimer's Disease**

Devika Shankar | Mentor: MJ Vijay Kumar

Alzheimer's Disease (AD) is an age-correlated neurodegenerative disorder that causes cerebral atrophy and neuronal death. Recent findings suggest G-quadruplexes (G4s)—secondary DNA structures formed in guanine-rich nucleic acid sequences—may contribute to brain aging and subsequent age-related neurodegenerative diseases as stabilizing G4s causes genomic instability, which explains the progression of aging and cellular degeneration. Thus, to understand how G4s are regulated in neurodegenerative cells, the expression of DHX36—a G4 helicase—was quantified to study how it controls various age and cellular senescence-related processes in the cell. Immunohistochemistry was used to compare DHX36's expression in young vs aged wild-type and AD Tg2576 mice. Aged Tg2576 had a higher DHX36 expression than wild-type, especially in the hippocampus compared to the cortex, and DHX36 was more highly expressed in aged Tg2576 than young. These findings confirm that AD pathology degrades hippocampal cells before cortical cells and that AD exhibits high G4 levels, so further understanding the mechanisms of G4s in aging will help advance novel therapeutic strategies for age-related neurodegeneration.

### **Determining Drift Time Resolution for XENONnT**

Kexin Shen | Mentor: Ivy Li

The international XENON collaboration uses a dual-phase liquid xenon time projection chamber (DP-LXe TPC) detector to directly detect dark matter. The detector measures rare interactions with liquid xenon, and the depth of particle interaction location can be reconstructed based on the drift time of the electrons freed from the interaction. Using Krypton (Kr83m) calibration data, the drift time resolution was determined to be  $21 \pm 3 \mu\text{s}$  after comparing results gained from three different methods: least-squares estimation, maximum likelihood estimation, and the Markov chain Monte Carlo method. Various data selection was applied to make sure the events correspond to the Kr interactions that happened within the fiducial volume, and we concluded that after the data selection, the drift time resolution is relatively high, and thus our depth measurements are reliable.

## **Elucidating the function of *E. coli* YcjX protein and its missense mutants**

Claire Shi | Mentor: Francis Tsai

Heat shock proteins (HSPs) are a family of stress-activated proteins that are induced in response to various forms of cellular stress. They function to help maintain proteostasis and regulate protein expression, playing an important role in cell survival. Among the major HSPs, the ((ycjX)) gene is highly upregulated under stress. The ((ycjX)) gene encodes for a conserved protein in gram-negative proteobacteria and is often located downstream from the pspABCDE operon. This operon encodes the phage shock proteins (Psp) involved in conditions of impaired inner membrane integrity. As such, YcjX may be involved in the cell envelope stress response. However, the precise function of YcjX is poorly understood. The crystal structure showed that YcjX is a GTP-binding protein. It features the canonical alpha-beta domain of Ras in addition to a unique helical domain proposed to be implicated in signal transduction. How missense mutations of residues in the switch 1 motif (G2 box), helical domain, and G4 box impact biological function is unknown. Here, I will present my findings to understand the mechanism and function of YcjX using mutant proteins and ((in silico)) characterization.

## **Investigating functional cooperative mutations of YTHDF2 in mutant p53-associated osteosarcoma**

Rachel Shoemaker | Mentor: Dung-Fang Lee

YTHDF2 is a gene which codes for a protein responsible for the cleavage of the poly-A tail from mRNA transcripts. Mutated in a multitude of cancers, it has primarily been indicated to be an oncogene. For individuals with LFS, who are predisposed to osteosarcoma (OS), among other cancers, a germline p53 mutation in accompaniment with a secondary mutation is indicated to induce OS formation. Using the OSA cell line with lentiviral infection of a p53-G245D expressing plasmid and the YTHDF2 shRNAs, the YTHDF2 gene will be analyzed for its tumorigenic abilities in conjunction with a germline p53 mutation to investigate how it impacts cell function. Research regarding the YTHDF2 knockdown will potentially identify a genetic mutation that results in the development of OS in LFS patients, and the understanding of its mechanistic impact on cell function will allow for the development of potential therapeutics in the future.

## **Improving RNA Memory Devices Through High Throughput Structural Feature Optimization**

Rishi Shridharan | Mentor: James Chappell

Antibiotic resistant bacteria claim millions of lives each year, and this threat is expected to multiply many fold by 2050. A major contributor to the spread of resistance is horizontal gene transfer (HGT), the process by which DNA moves through microbial consortia. While HGT has been well-studied in the lab, few tools exist to study HGT in nature. To address this gap, the Chappell Lab has developed

Ribozyme Addressable Memory (RAM), a system that uses self-splicing RNA ribozymes to append a synthetic barcode onto endogenous 16S rRNA, thereby enabling us to track HGT by sequencing barcoded RNAs. Past work demonstrated RAM's high specificity, however RAM barcodes only 0.001% of total target RNA, making it unable to detect rare transfer events. Here, we modified the ribozymal P1 bulge by introducing a randomized library in place of RAM's current sequence. We then performed iterative fluorescence activated cell sorting to find several variants that were more fluorescent than the existing system. These variants were found to be multimers, thus efforts are ongoing to modify other domains of the ribozyme, with the ultimate aim to find design rules for efficient ribozyme splicing.

### **Exploring the Role of Lipid Metabolism in *C. elegans* Host Defense During Liquid Killing**

Nikita Singh | Mentor: Natasha Kirienko

The gram-negative pathogen *Pseudomonas aeruginosa*, with its propensity to cause severe disease within immunocompromised patients and its ever-expanding range of resistance to drugs, is a critical target of study in today's medicinal world. Previously, the Kirienko lab identified the siderophore pyoverdine as a major virulence factor during *P. aeruginosa* pathogenesis against *Caenorhabditis elegans* in liquid (termed Liquid Killing, LK). Pyoverdine translocation into the host disrupts iron homeostasis, resulting in mitochondrial damage. Nonetheless, the full extent of host defense activation in *C. elegans* during LK is undetermined, with research pointing to lipid metabolism being involved. To identify relevant host defense genes, we examined several RNAi knockdowns of *C. elegans* lipid metabolism genes, of which several appeared to play a role in survival during LK. These experiments were supplemented with the agar-based Slow Killing (SK) assay to investigate if the role of lipid metabolism genes in promoting immunity was liquid specific. It was observed that, for the most part, lipid metabolism genes involved in LK host defense do not play a similar role within SK.

### **PPARGC1B Overexpression in Human Foreskin Fibroblasts to Promote Mitochondrial Biogenesis**

Mira Srinivasa | Mentor: Mario Escobar

Following trauma to the heart, such as cardiac arrest, damaged heart tissue converts into scar tissue produced by fibroblast cells. Because scar tissue does not possess the same capabilities as healthy heart muscle, minimizing this scarring can significantly promote the healing process. Increasing the number of mitochondria in human foreskin fibroblast (HFF) cells has been shown to be an effective way to reduce production of such scar tissue. Furthermore, the PPARGC1B gene is important in regulating mitochondrial biogenesis. In this study, we use a nuclease inactivated Cas9 protein (dCas9) to target PPARGC1B in HFF cells and cause overexpression. A derivative of the protein used in CRISPR-Cas9 systems, dCas9 can transcriptionally activate target genes, especially when fused to potent



mechanosensitive transcription factor-based transactivator domains such as NMS. Numerous locations on the PPARGC1B gene were targeted with these systems, and those found to maximize PPARGC1B expression were selected for further study. Specifically, the increase in mitochondria in activated cells was analyzed to confirm that PPARGC1B overexpression indeed increases mitochondrial production in HFF cells.

### **Elucidating the role of Ddx41 in Retinitis Pigmentosa**

Tanmay Srinivasa | Mentor: Qian Xinye

Inherited retinal dystrophies (IRD) are degenerative diseases of the retina which are marked by clinical and genetic heterogeneity [1]. Common symptoms of these disorders are night or color blindness, tunnel vision, and eventually complete blindness [2,3]. This paper explores the role of DEAD-box Helicase 41 (Ddx41) in cone and rod photoreceptor function. Ddx41 codes for a RNA helicase with the conserved motif of Asp-Glu-Ala-Asp (DEAD) which is part of the SF2 family of helicases [4,12]. This motif in Ddx41 is required for post-transcriptional gene expression which is involved in pre-mRNA splicing. Ddx41 has been implicated in breast cancer and has been identified to be mutated in patients with Retinitis Pigmentosa (RP) [13]. There are two specific mutations in the Ddx41 gene that could possibly be linked to the development of RP which are splicing and stopgain mutations. These mutations have been primarily found in exons 5 and 6 of the gene. This study examines the impact of a conditional knockout of Ddx41 on cone, rod, and retinal ganglion cell function in mouse models. We showed that the conditional knockout of Ddx41 causes degeneration of retina cells.

### **Comparison of FLASH-RT with Conventional RT on DNA Damage Pathways in Head and Neck Carcinomas**

Ananya Srivastava | Mentor: Michael Spiotto

Compared to conventional radiotherapy (RT), the recently developed FLASH-RT method delivers therapeutic doses of radiation at ultra-high dose rates (in microseconds) that has been proposed to be tumoricidal but almost spare normal tissues through still unclear mechanisms. We hypothesized that FLASH-RT will cause similar decreases in cell survival in HNSCC cell lines compared to conventional RT, but increased DNA damage markers. FLASH-RT and conventional RT were delivered to in vitro cultured HNSCC cells (SCC090, SQ20B, CaSki, HeLa, and SiHa) using a mobitron. Survival was assessed using clonogenic survivals, DNA damage expression markers were assessed using Western Analysis, and statistical significance was calculated using the t-test for continuous variables. We have previously compared the survival fraction of HPV-positive and HPV-negative HNSCCs to conventional and FLASH-RT. Here, we performed Western blots for  $\gamma$ -H2AX and eIF2 $\alpha$  which are involved in pathways underlying DNA repair and endoplasmic reticulum stress. This data will be utilized to understand why FLASH-RT may lead to less toxicity but the same efficacy as conventional RT.

## **Characterizing Components of FGF Signaling Pathway of *Danio rerio* During ENS Development**

Alexander Suh | Mentor: Lucia Rivas

The gut is regulated by a system of neurons and glial cells, forming the Enteric Nervous System (ENS). Through ENS regulation, the gut performs peristalsis, ion and water balance, and blood flow. ENS forms from neural crest cells (NCC) migrating into the gut, becoming progenitor cells that undergo differentiation into enteric neurons. Data from the Uribe's Lab single cell RNA sequencing revealed major and diverging subtypes of zebrafish NCC derivatives, highlighting components of the Fibroblast Growth Factor (FGF) pathway during the differentiation of NCCs to enteric neurons. In order to characterize the FGF pathway, we performed whole mount immuno-coupled hybridization chain reaction (WICHCR) on ((8.3phox2bb)):Kaede fish line, using probes against mRNA for ((fgf13b)), dpys13, hmx3a, and ywhag2, at fixed time points. Using WICHCRs we examine the expression and location of the FGF pathway genes in transitioning progenitor cells. Results will allow us to better characterize when the FGF pathway is involved in the development of the ENS. Future research will focus on determining the function of fgf13b and its role in the development of ENS based on spatial and temporal activation.

## **The Effect of DDC Inhibition on NEPC Tumor Microenvironment**

Jessica Suh | Mentor: Celia Mark

Neuroendocrine prostate cancer (NEPC) is a rare and aggressive form of prostate cancer. Our preliminary data suggest that NEPC is classified as a cold tumor, in which very few T-cells are present and do not properly respond to immune checkpoint therapy (ICT). Also, our analysis of publicly available RNA-seq data on advanced prostate cancer patients treated with immune checkpoint therapy showed that patients who responded poorly to ICT were enriched for NEPC. Despite its lethality, there are no effective treatments for this type of cancer. In this study, we aim to address this challenge by targeting DOPA decarboxylase (DDC), an enzyme that is highly expressed in NEPC cells. DDC is a key regulator in the metabolism of tryptophan, an essential amino acid that is critical for proper T cell function. The function of DDC in immunity has not yet been studied to the same extent as other enzymes in the kynurenine pathway. Thus, this project works to uncover the role of DDC in tumor growth and its microenvironment. It is expected that the overexpression of DDC in NEPC cells will lead to increased tryptophan metabolism, which will increase tumor cell growth and decreased T-cell proliferation.

## **Effects on Autophagy and Metabolomics Due to ALKBH5 Deletion in Smith-Magenis Syndrome**

Matthew Sun | Mentor: Elsea Sarah

Smith-Magenis Syndrome (SMS) is a developmental disorder characterized by its collective physical and neurodevelopmental symptoms, which include distinct facial features, obesity, learning disability, and sleeping disorders. As a rare disease, affecting only 1 out of roughly 25,000 individuals in the United States, it receives limited attention in the literature. It is caused by a deletion or mutation in one copy of the *RAI1* gene located on chromosome 17p11.2, and most 17p11.2 deletions encompass about 80 genes, including *ALKBH5*. *ALKBH5* codes for the ALKBH5 protein demethylase, which serves a role in RNA epigenetics by removing the m6A modification from target RNAs. It is hypothesized that a deletion of *ALKBH5* causes an increase in overall m6A modifications on mRNA, causing such transcripts to be prematurely degraded. The untranslated genes on these transcripts are possibly associated with the development of SMS. This project is concerned with the effects of the haploinsufficiency of *ALKBH5* on the transcriptome and autophagy functions through the use of control and SMS-derived lymphoblasts, and especially how these effects manifest in the phenotypes observed in SMS.

## **Using CUT&RUN to Assess the Interaction Between Yap and Atn-1 in Neural Crest Cells**

Kihan Sung | Mentor: Jun Wang

Neural crest cells (NCCs) are characterized as a stem cell population in vertebrate embryogenesis that can differentiate into multiple cell types, including smooth muscle cells, osteoblasts, and chondrocytes. Dysregulation of NCC differentiation has been correlated to developmental defects and diseases, such as craniofacial aberration and congenital heart defects. The Hippo pathway, a conserved fundamental pathway, helps regulate the specification, migration, survival, and differentiation of NCCs. Yes-associated protein (Yap) and its paralog transcriptional coactivator with PDZ-binding motif (Taz) are downstream effectors of the Hippo signaling pathway. Activated Yap/Taz is able to alter gene expression as a transcriptional activator and repressor. Nonetheless, the function and mechanism of Yap/Taz as co-repressor in NCCs remain unclear. Atrophin 1 (Atn1) is a well characterized nuclear co-repressor. However, its role in NCCs has yet to be studied. Here, using CUT&RUN technologies, we found that, at genome wild, many potential Yap targets are shared with Atn1, suggesting a novel mechanism in which Yap/Taz carries out its repressor functions through interactions with Atn1.

## **Phosphorylation of TAZ by DNAPK induces Glioma Stem Cell Radioresistance**

Tiffany Tang | Mentor: Krishna Bhat

Glioblastoma (GBM) is a primary brain tumor that is virtually incurable, with current therapeutic approaches, such as anti-PD-1, that are very successful in other cancers, but have little success in GBM. Genomic analyses of patient studies classified GBM into 3 major molecular subtypes: proneural (PN), classical, and mesenchymal (MES), with MES type GBM associated with the worst survival and rate of recurrence. TAZ, identified as a master regulator of the MES phenotype, drives the PN to MES transition in glioma stem cells (GSCs). Previously, we showed that DNA-dependent protein kinase (DNAPK) governs TAZ stability via phosphorylation—however, it remains elusive how this interaction alters GSC sensitivity to ionizing radiation, the primary therapeutic intervention for GBM. We demonstrated that knocking down TAZ increases the number of  $\gamma$ H2AX foci post irradiation. Furthermore, we demonstrated via cycloheximide chase assays that DNAPK inhibitor treatment reduces the half-life of TAZ. Overall, this study reports how interaction of DNAPK with TAZ globally induces a GSC radio-resistant phenotype, highlighting the potential role of TAZ as a therapeutic target for GBM.

## **Intestinal Oxytocin: qPCR-Based Genotyping and Expression Analysis in Mice**

Aanchal Thapa | Mentor: Sara Di Rienzi

Hypothalamic oxytocin has a repertoire of beneficial health effects from social bonding to promoting hair and skin growth. Research regarding the connection between the human gut microbiome and health, from the Britton Lab, has detected oxytocin in the gastrointestinal system - a novel finding. However, the exact location and function of oxytocin in the gut remain unclear. Here, we investigated the presence of oxytocin in different regions of the gastrointestinal epithelium using qPCR on mice samples. We also developed a qPCR-based genotyping assay to aid in the breeding of mouse models lacking intestinal oxytocin. Our findings suggest that oxytocin is present in low levels throughout the gut, including the stomach, cecum, large intestine, and small intestine, but is not associated with the standard gut hormone cells, the enteroendocrine cells. This novel insight into the production and distribution of oxytocin in the gut could pave the way for more precise therapeutic use of the gut microbiome in promoting health. By shedding light on the function of gut hormones in general, our study also contributes to a deeper understanding of the gut-brain axis and its role in overall health.

## **The Effects of ATG8, Poly-Glutamine, and TOR Signaling in Muscles on Autophagic Processes in *Drosophila Melanogaster***

Maanvi Thawani | Mentor: Srivastav Saurabh

Hereditary Spastic Paraplegia (HSP) is a group of neurodegenerative disorders caused by mutations in over 72 genes that lead to muscle spasticity and locomotor

deficits. Poly-ubiquitin aggregation has been seen in many neurodegenerative disorders, as they are often linked to attenuated autophagy. One of our HSP genes of interest include *Atlastin 2*, which encodes an ER shaping protein that has implicated ER morphology as a factor in HSP. It has been previously indicated that the loss of *atlastin* leads to defects in autophagosome-lysosome fusion and decreases Tor activity in muscle - both of which are important parts of autophagy. We are aiming to understand how autophagy may be affected by the muscular expression of ATG8, poly-glutamine, and the alteration of Tor signaling. To describe the roles of these proteins, we conduct Immuno-fluoro-chemistry to detect poly-ubiquitin aggregates and the neuromuscular junctions, and Western Blots to detect protein levels for ATG8a in *Drosophila melanogaster* models.

### **Creating *Caulobacter Crescentus* Strains with High Recombination Efficiency**

Helen Tian | Mentor: Bobby Tesoriero

Engineered Living Materials (ELMs) are inspired by naturally occurring living materials that can grow bottom-up from progenitor cells into larger structures and complexes. With ELMs, we can use synthetic biology to construct strains of bacteria that can self-interact and have novel and unnatural properties. Currently, there is a system for doing just that in *Caulobacter crescentus*. *C. crescentus* is a gram-negative bacterium that can be found in lakes and has a paracrystalline S-layer protein encoded by the RsaA gene. However, there are some limitations of strain making. Notably, *C. crescentus* strains take many weeks to isolate successful colonies and have very low integration efficiencies which lengthen this timeline and is also resource intensive. Furthermore, the low efficiency of this process also makes it difficult to determine if an insert is toxic to the cell or needs further screening. Hence, to avoid this issue, we will be testing out whether the CRAGE (chassis-independent recombinase-assisted genome engineering) system that utilizes site-specific Cre recombinase integration with *Lox* steps will allow us to integrate our insertion cassette at high efficiency.

### **Effect of the Expression of SPO1 Genes 45 and 46 on *Bacillus subtilis* Cell Division**

Jason Tran | Mentor: Charles Stewart

Infection of the bacterium *Bacillus subtilis* by bacteriophage SPO1 redirects the host's biosynthetic machinery for phage reproduction. Previous research implicates several genes of the SPO1 genome as responsible for this host-takeover process, such as gene 56 inhibiting host cell division. Preliminary findings imply that the products of genes 45 and 46 (gp45/46) of the SPO1 genome also contribute to inhibiting cell division. To test this hypothesis, genes 45 and 46 were expressed in uninfected cells from an inducible promoter. Induction of expression caused loss of viability without preventing continued increase in cell mass, as shown by

increasing turbidity. Expression of gp45/46 led to decreases in cell viability over time while turbidity continued to increase. A possible reason for this is that gp45/46 inhibits cell division without preventing continued cell growth and this inhibition causes cell death. Microscopic analysis aims to confirm this continued cell growth and lack of cell division by measuring cell lengths. As time after induction increases, induced cells are expected to be longer because they will continue growing and will not divide into smaller cells.

### **Evaluating the Impact of Urbanization on Fungal Endophyte Prevalence in Cool-Season Grasses**

Mallory Tucker | Mentor: Josh Fowler

Predicting how urban environments influence species' adaptations to climate change is a crucial goal of global change biology. Here, we investigated how urban land cover influenced the prevalence of facultative fungal symbionts within museum specimens of cool-season grasses (*Agrostis hyemalis*, *Agrostis perennans*, and *Elymus virginicus*) collected across rural and urban environments. The endophytic fungi (genus *Epichloë*) provide benefits to their hosts including protection from herbivory, drought tolerance, and increased nutrient absorption. With these historic specimens, we evaluated changes in endophyte prevalence rates across ~150 years. Endophyte prevalence increased over time but the effect of urban cover on these responses varied with latitude. In northern environments, urban cover had a positive effect on endophyte prevalence, suggesting that endophytes provided protection from environmental stress in urban environments in the region. Adaptive responses to climate change mediated by species' microbiomes are likely to grow in importance with increasing urbanization around the world, which can exacerbate rising global temperatures.

### **Synthesis of a Novel Macrocycle for Catalysis of CO<sub>2</sub> reduction**

Agustin Valles | Mentor: Raul Hernández-Sánchez

The catalytic conversion of carbon dioxide to liquid fuels is being intensely pursued as a method by which to address current climate problems associated with large amounts of CO<sub>2</sub> emissions. A promising strategy to achieve this goal relies on the electrochemical reduction of CO<sub>2</sub> to products such as carbon monoxide and formic acid. The first step of this reduction is the formation of the radical anion CO<sub>2</sub>•<sup>-</sup>, an unstable species with an extremely short half-life. In this work, we explore the possibility of catalyzing CO<sub>2</sub> reduction via the use of a newly synthesized octa nitro macrocycle. We rely on the synthesis of resorcin[4]arene cavitands that have aromatic C-H bond donors within the inner cavity of the macrocycle. Introduction of electron withdrawing nitro groups to the aromatic flanking units of the resorcin[4]arene species increases the electropositivity of the hydrogen atoms allowing for strong hydrogen bond interactions to species hosted within the cavitand. The catalytic activity of our octanitro cavitand is investigated through

cyclic voltammetry experiments. This work illustrates an approach to catalyzing CO<sub>2</sub> reduction via strong non-covalent interactions.

### **Developing a CRISPR-Cpf1 tool to edit the genome of a coral endosymbiont**

Saksham Vashistha | Mentor: Michael Gustin

Rising ocean temperatures threaten the survival of coral reefs due to massive bleaching events. During bleaching, the coral symbiont – a eukaryotic dinoflagellate, Symbiodinium – is ejected due to thermal stress. A novel CRISPR-Cas system – Cpf1 – has shown great promise in editing the genome of eukaryotic organisms. We believe that by genetically editing the symbiont, it is possible to induce thermotolerance and resistance to environmental stress, possibly preventing bleaching. We have designed a modular DNA cassette containing DNA encoding for Cpf1, its guide RNA, and promoter & terminator sequences. Our target species is *Cladocopium goreaui*, one of the most common classes of Symbiodiniaceae in the world. *C. Goreaui* contains URA3, a gene involved in uracil biosynthesis. The URA3 protein will also convert the nontoxic 5'FOA to a toxic product. Loss of this gene in uracil-containing media will confer resistance to 5-FOA, thus allowing selection for DNA-transformed cells. We hypothesize that by targeting this gene for knockout, we can show the efficacy of our novel genetic engineering system and possibly target genes in the future to promote thermotolerance.

### **Combinatorial CRISPR-Cas9 Screens to Identify Colorectal Cancer Synthetic-Lethal Interactions**

Darren Wang | Mentor: John Paul Shen

Genetic interaction suggests a relationship between genes or signaling pathways as simultaneous mutation of two genes can lead to an unexpected combined effect when compared to doing so on an individual basis. In colorectal cancer, interactions between frequently mutated oncogenes are not clear, and studying this area can help with both understanding and treatment. Hence, our research team is performing CRISPR-Cas9 screens on colorectal cancer cell lines via a combinatorial guide RNA library. I have focused on cell culture work to prepare samples for next generation sequencing. After that, PCR amplification of DNA and subsequent sequencing at various time points will be used to gauge synthetic lethality. To verify successful PCR amplification, gel electrophoresis and Bioanalyzer runs were also completed. We have yet to have a successful sequencing run, but we are getting close and this would provide more concrete data. With these results across multiple cell lines, we could then create a genetic interaction map and identify potential targets for drug therapy.

## **Determining mechanisms of fluconazole resistance in *Candida auris* through a genetic screening of mutants**

Amilia Warkentine | Mentor: Michael Lorenz

*Candida auris*, a human pathogenic fungus, has become a severe clinical problem. Since its initial discovery in 2009, *C. auris* outbreaks have been reported in six continents. One factor contributing to its rapid spread is the fungus' exceptional ability to withstand environmental stresses. In hospitals, disinfection techniques fail to eradicate the robust fungus, leading to nosocomial infections. Additionally, *C. auris* is highly resistant to antifungals, particularly fluconazole. This resistance to treatment contributes to the high mortality rate associated with infection. However, the genetic mechanisms that allow *C. auris* to circumvent environmental stress and clinical treatment remain unknown. Uncovering these mechanisms could reveal therapeutic targets and new treatment options. Using an *Agrobacterium*-based mutagenesis strategy, we generated a library of *C. auris* mutants with random gene disruptions. To determine pathways necessary for drug resistance, we designed a high throughput assay to screen these *C. auris* mutants for fluconazole sensitivity. We then identified a *C. auris* mutant strain exhibiting fluconazole sensitivity.

## **Characterizing the NAADP-Binding Domain of the *Lsm12* Protein Using Modified pET Plasmids in *E. coli***

Angel Xu | Mentor: Kunal Shah

NAADP is a secondary messenger that binds to the receptor protein *Lsm12* to trigger endolysosomes to release  $Ca^{2+}$ , which is used in intracellular signaling mechanisms such as muscle contraction. Previously, the *Lsm* domain of the *Lsm12* protein was identified as the NAADP receptor on endolysosomes. However, we do not yet know which sequence in this domain is responsible for function: furthermore, a more efficient method of analyzing *Lsm12* and confirming experiment results is needed. In this experiment, we analyzed the functionality of the *Lsm* domain by transforming *E. coli* cells with a modified pET vector plasmid containing a *Lsm12* gene. By selectively cloning pET vector-containing cells and isolating the plasmids using the Maxiprep protocol, we affordably and quickly built up a large stock of the *Lsm12* gene. Next, we discovered through plasmid DNA sequencing that the restriction enzymes *Bam*HI and *Hind*III-HF could be used to cleave the *Lsm* domain from the plasmid. These domains were modified with alanine substitutions and recombined with *E. coli*: the functionality of the *Lsm12* proteins produced from these cells show which mutated sequences result in a loss of function.



## **The Narrow Thorny Ganglion Cell: an S-ON S-OFF Ganglion Cell in the Primate Retina**

Emma Yang | Mentor: Emma Yang

A key question in neuroscience is how lower-level sensory responses modulate higher-level cortical processing to drive our daily actions. For example, there is debate about the extent to which the primate retina participates in visual computation. One view states that most calculations occur in the cortex; a competing view argues that many occur before or at the level of retinal output at the ganglion cell. Here, we approach one pathway in this debate by examining cells presynaptic to inner- stratifying narrow thorny ganglion cells in macaque retina. They were known to project to early motor response centers like the superior colliculus and through the LGN to the middle temporal area. However, little was confirmed about their retinal inputs. Here we show that these cells receive input from bipolar cells that are excited by short-wavelength and inhibited by long-wavelength light. They also receive input from amacrine cells that exhibit the inverse response. This input pattern suggests that inner narrow thorny cells show transient responses to changes in blue-yellow contrast, allowing them to support non-image forming vision driving motor responses independent of cortical processing.

## **The role of *hnRNPC::RARG* fusion in acute promyelocytic leukemia-like acute myeloid leukemia**

Matthew Ye | Mentor: M James You

Acute promyelocytic leukemia (APL), a subtype of acute myeloid leukemia (AML), is characterized by the fusion gene PML::RARA. Early intervention using all-trans retinoic acid (ATRA) results in remarkable recovery. However, cases have emerged in which patients, despite similar morphological and clinical signs of APL, showed no such recovery. Noteworthy, these patients lacked PML::RARA, instead presenting with a non-canonical fusion between RARG and a promiscuous set of partners, such as hnRNPC. We propose that the retinoic acid receptor encoded by RARG, despite high homology to that of RARA, confers insensitivity to ATRA, a differentiating agent. Primers were designed to amplify hnRNPC::RARA and hnRNPC::RARG inserts via overlapping extension PCR. These were ligated into a pCDH backbone, and the resulting constructs were used to create third-generation lentiviruses, packaged using HEK-293T cells. Human APL cells were infected in vitro to create expression systems for the two inserts. Assessing differences in proliferativity between these two systems after administration of ATRA will elucidate the role of RARG in “APL-like AML” and aid in the development of novel therapies.

## **Prioritizing the Regulatory Non-Coding Genome for Disease Causal Variants in Retinal Diseases**

Lauren Yu | Mentor: Rinki Ratnapriya

Inherited retinal diseases (IRDs) are characterized by progressive vision loss due to death or dysfunction in retina and retinal pigment epithelium (RPE) tissues. Significant progress has been made in identifying the genetic cause of IRDs, with over 270 genes identified to date. However, mutations in the protein-coding regions of these genes yield successful genetic diagnoses in about 40-70% of IRD cases. One possibility for improving genetic diagnosis is to expand the search beyond the coding regions of the implicated disease genes. Gene expression regulation is emerging as a dominant mechanism in mediating disease risk via non-coding variants. Additionally, trait- and disease-associated variants are enriched in cis-regulatory elements (CREs) such as promoters and enhancers that can bind to transcription factors (TFs) and regulate gene expression. This project analyzes CREs and gene expression in human retina and RPE tissues to identify putative CREs in IRD-causing genes.

## **Aberrant Activation of FOXO1 in Spinocerebellar Ataxia Type 1**

Leo Zhang | Mentor: James Orengo

Spinocerebellar ataxia type 1 (SCA1) is a progressive autosomal-dominant disorder caused by a CAG triplet repeat expansion mutation in the ATXN1 gene. Recent studies have implicated motor neuron degeneration in the development of aspiration pneumonia in SCA1, which weakens breathing muscles and ultimately leads to premature death. In other neuromuscular disorders, aberrant activation of the JNK signaling cascade appears to inhibit activation of the transcription factor FOXO1, which is responsible for upregulating expression of Bnip3 and Bim, initiating neuronal autophagy and apoptosis. Ongoing research in the Orengo Lab shows increased levels of phosphorylated JNK in SCA1. This study seeks to establish a linkage to these current findings by investigating JNK inhibition of FOXO1 as a potential cause of motor neuron death in brainstem tissue extracted from the well-characterized SCA1 mouse model. Interestingly, our findings actually show increased activation of FOXO1 paired with increased expression of Bim and Bnip3, thereby implicating the Bim-related apoptosis pathway as a potential contributor to premature death in SCA1.

## **Gene Augmentation Therapy to Rescue Degenerative Photoreceptors in a *Cwc27* Mutant Mouse Model**

Karen Zheng | Mentor: Jiaxiong Lu

A previous study involving *Cwc27 frameshift knockout* mice has validated photoreceptor cell degeneration as the main defect of *Cwc27* loss. However, the possibility of morphological and functional rescue of the degenerated homozygous mutant *Cwc27* retina by gene augmentation therapy has yet to be explored. The *Cwc27 compound heterozygous (Cwc27<sup>loxp</sup>/K338fs)* mouse model established

for this study displays retinal degenerative phenotypes by 6 months of age. Mice retinas treated with subretinal injections of AAV8-*GRK-Cwc27-FLAG* revealed improved functionality and morphology of the retina. At 9 months post-injection, gene therapy injected eyes generated increased electroretinogram (ERG) wave amplitudes compared to their PBS-injected counterparts. H&E staining revealed that the treatment had a partial rescue effect on photoreceptor degeneration. Immunostaining analyses revealed exceptional rescue of cone cells in AAV-injected eyes compared to PBS-injected eyes. These results suggest that gene augmentation therapy using AAV8-*GRK-Cwc27-FLAG* is a promising approach for alleviating retinal degeneration caused by loss of *Cwc27*.

### **Structural basis of cytarabine-mediated inhibition on DNA-synthesis**

Grace Zhou | Mentor: Caleb Chang

With cancer as one of the most fatal diseases, effective treatment methods are highly necessary. Chemotherapy is the most effective known method of treatment but results in many aversive side effects. Additionally, the development of chemotherapy drugs require inefficient and costly high throughput assays. AraC and Zalcitabine are common chain terminators in DNA synthesis. As a nucleoside analogue, AraC has shown potential to be an effective drug against cancers including leukemia. It is hypothesized that the mechanism of inhibition by AraC is structural. The results show that AraC at the primer terminus is more prone to be misaligned during correct nucleotide incorporation. In crystallo reaction reveals that steric clashes prevent proper primer alignment.

# Social Sciences

## Poster Presentations

### **Candidate Race and the Effects of Misinformation on Voter Trust**

Maya Adhikari, Luisa Bustamente Tolda, Liza Jacob, Bianca Schutz | Mentor:  
Joseph Cozza

Social identity theory is used by people to establish group membership, dividing others into “in-groups” and “out-groups,” which is often based on race. This paper aims to examine the effect of survey participants' and political candidates' racial identity on politician trust by investigating whether participants are willing to punish misinformation shared by members of racial “out-groups” as compared to their “in-group”. We will examine whether participants would be more inclined to change their level of trust if provided evidence of misinformation if a candidate is a member of the out-group. We will employ t-tests, ANOVAs, and OLS models to assess responses to our online Mturk-based survey conducted the week of 3/12 to 3/19. Each survey participant will be randomly sorted into one of three treatment groups to receive a biography about a candidate running for mayor. The only difference is the race of the candidate, where we present Latino, Black, and White candidates. Participants will then be presented with a Tweet posted by the candidate followed by a fact-check of the post. After both readings, participants will be asked questions rating their trust in the candidates.

### **Self Determination Theory in Spousal Caregiving: The Relationship Between Psychological Need Fulfillment, Perceived Stress, Chronic Inflammation, and the Role of Motivation Autonomy**

Daniel Argueta | Mentor: Christopher Fagundes

As life expectancy increases, Alzheimer’s disease and related dementias (ADRD) have become more common, and exploring processes that lead to stress among caregivers is increasingly important. Current literature examines the role of proinflammatory cytokines (serum IL-6) in chronic stress. Self-Determination Theory (SDT) provides a useful framework for understanding the ways in which psychological needs fulfillment affects the stress associated with spousal caregiving. Motivation autonomy with which spouses give care has affected previous research examining psychological need fulfillment and associated wellbeing outcomes. So far, relatively little research exists specifically examining stress in particular within this framework. The present study aims to establish the relationship between psychological need fulfillment and stress, as well as the role of motivation autonomy. Specifically, we expect psychological needs fulfillment in ADRD spousal caregivers to experience less psychological and immunological stress. The goal of this work is to inform future intervention that aims at fulfilling psychological needs as a protective factor for ADRD spousal caregivers.

## **Increasing Awareness and Assessing Intervention Effectiveness Among Minority Women Populations: A Human Papillomavirus Prevention Initiative**

Anish Attarde, Eunbi Chung, Aanika Kashyap, Priya Tirumala | Mentor: Michael Jaung

Human Papillomavirus (HPV) is the most common sexually transmitted infection and can cause cervical cancer. The HPV vaccine is over 90% effective, yet 70% of Americans are unaware of HPV. We investigated if an education intervention in a safety-net emergency department can improve knowledge and perception of the vaccine. To target at-risk patients, women between ages 18-45 were recruited. A pre-intervention assessment was performed. Informational brochures were used as an educational intervention in the patient's preferred language, followed by a post-intervention assessment. Patients were given a 2-week follow-up call regarding social media usage, willingness, and actionable steps to receiving the HPV vaccine. An initial analysis of 131 participants showed a 101% increase in correct responses in pre- and post- knowledge assessments. Responses were statistically analyzed, demonstrating interest in the HPV vaccination, intent to receive the HPV vaccination, and knowledge gained. By increasing understanding of HPV, its effects on cervical cancer, and prevention methods, this intervention may improve health outcomes for many women.

## **Investigating Academic Motivation Types in Undergraduate Students**

Martina Awad, Natalie Diaz, Rachel Ivany | Mentor: Chase Lesane-Brown  
College students are motivated to participate in school for many reasons. Understanding these academic motivations can optimize students' learning styles and future goals. The present study investigates academic motivation types in undergraduate students based on students' schools of study (STEM vs. Non-STEM) and gender identity. Rice undergraduate students will complete an online survey assessing intrinsic (e.g., to know and toward accomplishment) and extrinsic motivation (e.g., external regulation) types (Vallerand et al., 1992). Overall, we expect students to score higher on intrinsic motivation than external motivation. STEM majors will be motivated by an intrinsic desire to know; Non-STEM majors will be motivated by an intrinsic motivation toward accomplishment. We expect undergraduate students who identify as women to rank higher overall on intrinsic motivation than those who identify as men, non-binary, or any other specified gender identity. The results may help instructors and learners develop education plans that maximize students' motivational type.

## **Identifying Factors Affecting Rural Rice Students' Decision in Accessing Preventative Gynecological Care**

Nafisa Azizi | Mentor: Craig Considine

As life expectancy increases, Alzheimer's disease and related dementias (ADRD) have become more common, and exploring processes that lead to stress among caregivers is increasingly important. Current literature examines the role of proinflammatory cytokines (serum IL-6) in chronic stress. Self-Determination Theory (SDT) provides a useful framework for understanding the ways in which psychological needs fulfillment affects the stress associated with spousal caregiving. Motivation autonomy with which

spouses give care has affected previous research examining psychological need fulfillment and associated wellbeing outcomes. So far, relatively little research exists specifically examining stress in particular within this framework. The present study aims to establish the relationship between psychological need fulfillment and stress, as well as the role of motivation autonomy. Specifically, we expect psychological needs fulfillment in ADRD spousal caregivers to experience less psychological and immunological stress. The goal of this work is to inform future intervention that aims at fulfilling psychological needs as a protective factor for ADRD spousal caregivers.

### **Perceptions of the Pandemic**

Sarah Bartos, Shaun Kerry, Nia McCarde II, Aaliyah Mobley | Mentor: Sandy Parsons

Our study investigates Rice students' experiences due to the COVID-19 pandemic and their perceptions of others who matriculated to Rice at different times during the pandemic. Participants will rate the social wellness of a vignette that describes a student's circumstances adjusting to college and the restriction levels in college and high school. We expect students to rate vignettes that mirror their own circumstances as worse than other vignettes. Additionally, we anticipate that regardless of the participant's year of matriculation, they will rate the vignette describing a student who enrolled in Fall 2020 or Spring 2021 as lower. Before reading these vignettes, some participants will reflect on their COVID-19 experiences, and we predict that those who were prompted to reflect will have more extreme ratings for sociability and wellness than those who did not reflect. As a result of the research, we believe accommodations and acknowledgment should be made for students whose Rice experiences have been affected. Additionally, we hope that Rice University students and staff can work together to create a more socially and emotionally healthy environment for all students.

### **Reactions to Athletes: Perception of International Student Athletes with Mental Health Issues**

Maria Budin | Mentor: Mikki Hebl

The rate of mental health issues in college students has grown dramatically in recent years (Duffy et. al, 2019). These numbers might still underestimate the problem given that disclosing mental health issues can still be stigmatizing to many (Bird et al., 2018). Not surprisingly, different groups may face more stigma than others. In the current study, I am interested in examining one particular severely under researched group of college students – those who are international athletes – to see how they are perceived when it is discovered that they have mental health issues. This study employs a 2 X 2 design in which we present coaches with information on their international versus domestic athlete who either does or does not have a mental health issue. We anticipate greater stigmatization of those who have mental health issues, particularly when they are international student athletes. This work contributes to a very small body of research on the importance of examining the international college athletes' perspective and the possibility that the amount of stress that they face is compounded by more intense reactions from their coaches for falling short of being perfect.

## **“Seeing Double”: Do Positive Emotions Reduce Own-Race Bias?**

Victoria Chang, Mimi Filkin, Eleanor Loden, Ambreen Younas | Mentor: Sandra Parsons

Our research seeks to expand upon the recent literature on how positive emotions can influence own-race bias (ORB). Specifically, we'll examine Rice University students from Asian and White backgrounds since they form Rice's racial majority. We hypothesize that viewing the positive emotion-inducing video would result in better recognition of both races for all participants, reducing ORB, compared to neutral emotion. We also expect to find that the participants experiencing positive emotions will be significantly better at recognizing other-race faces than those in the neutral condition. Our research is significant as ORB can affect how a person interacts with people from another race. Finding a way to reduce ORB can help promote cross-racial relationships. Furthermore, our research is important as we are combining the research on positive emotions effect on attention and memory (based off of broaden-and-build theory) with ORB specifically here at Rice. Our evidence can help guide future techniques for memory improvement, crucial for eyewitness testimonies and in promoting better interracial relationships in several social settings.

## **Undergraduate Experiences and Mental Health**

Katherine De Paz, Serena Kim | Mentor: Chase Lesane-Brown

Depression and anxiety are the two most common mental health (MH) problems reported by undergraduate college students. Prior research suggests that depression and anxiety may be associated with relationships with family members and individuals' cognitive-emotional strategies. We aim to explore the relationship among family relationships, family stigmas towards MH, and cognitive-emotional regulation strategies that may affect the depressive and anxious symptoms of undergraduate college students. Participants will be recruited through SONA and fill out an online survey on Qualtrics. We hypothesize our data will show a negative correlation between familial relationships and emotion regulation strategies such as cognitive reappraisal with depressive and anxious symptoms. We also expect to see a positive correlation between expressive suppression as well as familial stigma of MH and depressive and anxious symptoms. Our study may better inform colleges of barriers and mitigators of MH related and potentially assist in improving interventions by providing necessary data on ideal emotional coping strategies, family involvement, and aspects of MH stigma.

## **Predictors of Imposter Syndrome & Its Impact on Psychological Wellbeing**

Olamide Daramola, Cherish Loper | Mentor: Chase Lesane-Brown

Many college students experience imposter syndrome, which is feeling incompetent despite evidence of competence. Experiencing imposter syndrome can harm one's psychological well-being when individuals fail to internalize their success. This study aims to examine predictors of imposter syndrome and the relationship between imposter syndrome and mental health (i.e., depression, anxiety, and stress). We will recruit undergraduate college students at a private university. Students will complete an online survey that includes the Clance Imposter Phenomenon scale and the Depression, Anxiety, and Stress Scale. Participants will also indicate their gender and racial identity. We

hypothesize college students who identify as members of an underrepresented group (i.e., women and racial/ethnic minorities) will experience higher levels of imposter syndrome. We also hypothesized that students who have high levels of imposter syndrome will score high on the depression, anxiety, and stress scales. We hope this study will illuminate predictors of imposter syndrome and the negative psychological outcomes that follow to better educate universities in supporting underrepresented college students.

## **Impact of Gratitude Interventions on Resilience through the COVID-19 Pandemic**

Margaret Dorsey, America Malacara, David Palmer, Angela Torres | Mentor:  
Sandra Parsons

In the past three years, we have witnessed a severe mental crisis plague the world. In our study, we argue that, based on evidence from gratitude interventions in the field of positive psychology, individuals who are asked to recall positive memories rather than neutral memories will score higher on reputable gratitude and resilience scales. We borrow the question stems from the study we replicate. Like the creators of that study, we base our hypothesis on Frederickson's broaden-and-build theory. We argue this theory is relevant to our study because by inducing a positive emotion, individuals increase their own resources. Our study will measure participants' post-reflection gratitude and resilience using two reputable scales, respectively the GQ-6 and RS-14. From their answers on both questionnaires, we will conduct two independent t-tests to calculate the difference in scores between those who participated in the gratitude intervention and those who did not. If our hypothesis is supported by the data we collect, we hope to encourage greater use of gratitude interventions, since it is such an accessible technique to use when coping with the aftermath of the COVID-19 pandemic.

## **Driver's Responses to Stopped and Slowed Lead Vehicles During Nighttime**

LeGrand Dudley | Mentor: DeLucia Patricia

Rear-end collisions comprise approximately 29% of all crashes, with the majority being the result of about 70% involving stopped lead vehicles and about 30% involving slow-moving lead vehicles. Prior research suggests drivers will not respond to a lead vehicle until it's perceived as an immediate hazard at .006 rad/s. However, a recent daytime study found that drivers respond in gradual phases to stopped lead vehicles. The current study aims to investigate if the result was consistent at night without daytime visual cues. We hypothesized that drivers would gradually respond as they approached a stopped or slow-moving vehicle and that they would respond later at night compared to in the day. A driving simulator recorded optical expansion rate and time on screen at six driver response inputs. Results suggest two groups of participants differ in response to slow-moving vehicles; one group released the accelerator and one group applied unanticipated-level braking. Analyses revealed that time on screen was shorter in nighttime than daytime for slow-moving lead vehicles, suggesting that drivers can better estimate time-to-contact in the daytime and respond effectively.



## **Just like little adults? Comparison of pediatric and adult firearm deaths in a large urban county to inform injury prevention**

Ojas Dumbre | Mentor: Bindi Naik

Purpose: Firearm injury is now the leading cause of death in children and adolescents. Hospital-based violence intervention programs are geared towards adults and suicide prevention is focused on mental health. It is unclear whether these interventions are effective to prevent pediatric firearm deaths. We hypothesized that pediatric and adult firearm injury deaths are different enough that they require different prevention strategies. Methods: Retrospective review of medical examiner records of deaths caused by firearm from the largest urban county in Texas. Demographics, injury data, social data, and shooting circumstances were collected. Data from pediatric (ped) patients (0-15 years) was compared to adults. Results: Between 2018 and 2020, there were 117 pediatric firearm victims (median age 14) and 1,803 adult victims (median age 39). The majority of victims were of Black race (ped 44% vs adult 37%) and male (ped 86% vs adult 87%). Homicide was the leading shooting cause for both groups (ped 58% vs adult 55%); however, the prevalence of suicide and unintentional shootings differed significantly (suicide ped 21% vs adult 42%,  $p < 0.01$ ; unintentional ped 16% vs adult 1%,  $p <$

## **The Relationship Between Trauma Subtypes And Associated PTSD And C-PTSD Symptoms In Military Veterans**

Julia Engelhardt | Mentor: Stephen Glatt

Complex PTSD (C-PTSD) is recognized by the international community as a sister disorder to PTSD. C-PTSD differs from PTSD in the nature of the type of trauma that the individual was exposed to, specifically trauma that is prolonged and inescapable in nature, and results in a symptomatology of disturbances in self organization (DSO). To receive a diagnosis of C-PTSD, an individual must meet the criteria for PTSD (re-experience, avoidance, and sense of threat), as well as DSO symptoms (affect dysregulation, negative self concept, and interpersonal disturbances). Current diagnostic criteria for PTSD and C-PTSD allows for a multitude of combinations of symptoms and symptom intensities for diagnosis. This research assessed the relationship between trauma subtypes and symptomatology in a population of veterans from Northern Ireland with exposure to different types of trauma, namely sexual traumas and physical traumas. Our findings indicate that the type of trauma an individual is exposed to will affect their subsequent symptomatology as there is an observable difference in the symptomatology of an individual based on the type of trauma they were exposed to.

## **Should They Have a Baby? Parenthood Desires of Educated Young Adults**

Leigh Gabriely, Radha Malhotra, Da Yon Jung, Muna Ogbunamiri, Ryann Tudor  
| Mentor: Sandy Parsons

For many, Family Planning (FP) is a critical part of life. However, there seems to be a lack of discussion and resources regarding FP on college campuses. These factors can lead to a lack of confidence, insufficient planning, and social pressure to delay FP. To learn what undergraduates find important in FP, we will conduct a survey using vignettes that describe an undergraduate senior. The vignettes differ in two factors: gender of the student (male or female) and post graduation plans (job, more school, undecided).

Subjects will be asked questions about the imaginary students' FP (number of children, when they should begin serious FP), and a series of demographic questions about themselves. We predict that women and individuals with post-grad plans will have a higher predicted number of children compared to men and individuals with no plans. We predict that increased time between graduation and a stable income will delay when subjects think the vignette student should implement FP. We hope undergraduate administrations will offer FP resources to students by providing guidance and safe spaces for FP discussion, and that students will feel more comfortable discussing FP with peers.

### **Murder or Mercy: Attitudes Towards Pregnancy Termination Among Undergraduate Students**

Jaden Geron, Jasmine Liou, Izzy Rawling, Sopheena Toovey | Mentor: Chase Lesane-Brown

The United States Supreme Court overturned Roe vs. Wade, giving way for Texas's state trigger ban that completely prohibits abortion. The aim of our study is to explore the attitudes of undergraduate students towards pregnancy terminations (PT) at a private university. We will replicate a Polish study (Stoklosa et al. 2021) that explored abortion attitudes of Polish university students. For our study, students will complete an electronic survey that gathers demographics (i.e., gender, school of study, religious affiliation, and political party affiliation) and attitudes regarding PT in different hypothetical cases to determine what specific demographic factors influence attitudes towards PT. We expect to find that women, students studying in the natural sciences, non-Catholics, and politically left-leaning students are more likely to support PT in all cases and choose PT for themselves or their partners in all cases compared to their counterparts. We hope our research will provide a better understanding on current attitudes towards abortion given recent legislation changes, and show how different demographic factors will associate with the pregnancy termination attitudes.

### **Exploring white matter correlates of picture naming in individuals with chronic stroke**

Catherine Grimme | Mentor: Randi Martin

Picture naming is a deceptively simple behavioral task that investigates single word processing. Previous research established a process model that includes visual processing, semantic identification of the picture, lexical retrieval of the name itself, and phonological processing for the word sounds, all before articulation occurs. Because of these many stages, there are multiple types of error that can occur, such as semantic error (dog vs. cat), phonological error (mat vs. cat), or mixed error (rat vs. cat), and an individual's pattern of errors can reveal semantic or phonological cognitive deficits. Performance on the Philadelphia Naming Test by 20 stroke survivors with left hemisphere damage was compared to the tract integrity of six left hemisphere white matter tracts to explore relationships between individual tracts and semantic or phonological processing. No tract was found to be significantly related to phonological processing, semantic processing, or overall performance, potentially signifying reorganization, or a more global process of picture naming. It is also possible that with greater power from a larger sample size would reveal relations with specific tracts.

## **Party ID in the USA: Revisiting Heuristics Theory in the context of Non-Partisan Elections**

Nadia Jenkins, Roselyn Ovalle, Jamie Stewart-Aday, Dean Toumajian | Mentor: Joseph Cozza

Heuristics theory has long held that voters use Party ID to allow them to make complex voting decisions with limited information about individual candidates. However, little research has been done to evaluate the impact of removing this key heuristic and conducting elections on a non-partisan basis—a practice used by 15 states for judicial elections and a commanding majority of large cities for municipal elections. Our research is among the first that uses experimental data to investigate whether the lack of party labels deters individuals from voting and whether some groups are kept from the ballot box more than others. Additionally, we investigate how often people—when not presented with party labels—vote with their co-partisan and are willing to seek more information about the candidates on their ballot.

## **Small Fish in a Big Pond: Family and Neighborhood Effects on Educational Attainment**

Elizabeth Kuhlman | Mentor: Shannon Cavanagh

In the context of education, “the frog pond” effect has been proposed as an explanation for why minority or lower-socioeconomic status students may perform worse in overall high-achieving schools than expected. In this paper, I test for the presence of the frog pond effect within the neighborhood environment using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). I use ordered logistic regression to predict midlife educational attainment based on parental and neighborhood educational background and own education expectations. My findings indicate no evidence for the frog pond effect at the neighborhood level. Furthermore, expectations of college attendance are correlated with weakened neighborhood and family effects, and parental education is the most significant predictor overall for college attainment.

## **Physical and Perceptual Differences Between Allophones, Quasi-Phonemes, and True Phonemes in English, Turkish, and Vietnamese**

Rosemary Lach | Mentor: Suzanne Kemmer

The purpose of this study is to analyze the physical and perceptual differences between phonemes that have different forms of phonological contrast in different languages. Particularly, it looks at the voiceless palatal and velar stops [c] and [k] in English, Turkish, and Vietnamese. These language and phoneme combinations are of interest, because in English, [c] and [k] are allophones, while they are quasi-phonemes in Turkish, and true phonemes in Vietnamese. Since there are functional differences in how each phoneme is used in each language in terms of phonological contrast, we can examine whether this relates to any phonetic differences in how the sounds are produced and perceived by speakers of those languages. This was tested by running three experiments on speakers of all three languages: spectrum analysis of the produced sounds, palatograms to determine articulation location, and a phoneme confusion test to measure perceptual distance. These tests revealed a difference between all three languages in terms of

distance between [k] and [c]. True phonemes showed the most physical and perceptual distance, followed by quasi-phonemes, and then allophones.

### **Disability at Rice: A Series of Stories**

Eli Mendoza | Mentor: Helena Fietz

When the Americans with Disabilities Act passed in 1990, all of Rice's new buildings needed to be compliant, and some other buildings were retro-fitted, at times very poorly. Rice infamously would not provide digital class options for disabled students until the COVID-19 pandemic, when it was necessary for all. As the pandemic subsides, Rice has not continued to provide the training and support necessary to continue these practices, which shows a lack of desire to create accessibility for non-able-bodied students. Rice as a university claims that it is its policy to provide “reasonable accommodations” to ensure equal access, but this policy has been insufficiently followed in practice. As such, I recently started trying to find what disabled life is really like for students, including those who aren’t visibly disabled like myself. Through quantitative and qualitative analysis of disabled students' experiences at Rice over the past two semesters, short stories have been written that are fictionalized accounts of real-life situations that show how much more energy disabled students must spend on everyday activities when disability inclusion is not taken seriously.

### **Prematurity and Emotion Regulation During Problem-solving**

Josselyn Munoz | Mentor: Dana DeMaster

Preterm (PT) birth increases the risk of disorders related to emotion regulation (ER). ER refers to the ability to modulate emotional arousal using goal-directed behavior. ER development is tightly linked to early experiences such that infants and toddlers rely on interactions with caregivers to increase ER skills through co-regulation. This study investigates ER in PT toddlers during the Tool Task, which is a problem-solving task consisting of 3 levels with increasing need for child ER and parent support of child ER through co-regulation. Here we investigate PT toddlers’ (age 15-30 months) ER relative to gestational age. There were 24 extremely PT (EPT; 22-27 gestational weeks, GW) and 16 very PT (VPT; 28-33 GW) children. We hypothesized that EPT children would have lower ER skills than VPT children. After correcting for age, there was no gestational effect. There was a significant effect in parent behaviors between the two gestational groups such that parents of EPT children showed a significant increase in responsive caregiving with task difficulty compared to VPT. These findings suggest that responsive caregiver behavior may contribute to PT children’s ER skills.

### **Pre-Trial Detention, Risk Management, and the Quest for a Sense of Objective Dangerousness**

Noah Rabkin | Mentor: Mark Jones

In 2019, New York State passed controversial bail reform as legislators denied judges the ability to look at a defendant’s “subjective sense of dangerousness” when setting bail. New York judges can now, except for violent felonies, only impose bail based on an arrestee’s “flight risk,” not if they deem them unsafe to the people around them upon release. Inspired by these judicial restrictions, I set out to answer whether dangerousness, specifically in the context of violent post-release crime and pre-trial detention, is

objective. Upon analysis of recent data from New York State, I found that a defendant's current arrest charge, as well as their age and gender, had a positive statistically significant effect on their likelihood of post-release violence. However, despite my findings seemingly challenging the foundations of bail reform, the paper is not an indictment of the reform itself. Rather, the data still indicates that the vast majority of those accused of non-violent crimes will remain non-violent. Consequently, bail reform still stands to be hugely successful, just, as my research indicates, at the expense of a slight uptick in post-release violence.

## **The Interaction Between Employees' and Leaders' Concerns about a Tobacco-Free Workplace Policy Implemented at Substance Use Treatment Centers**

Ammar Siddiqi | Mentor: Reitzel Lorraine

Tobacco-free workplace policies (TFWPs) are underused interventions that reduce elevated tobacco use among substance use treatment center (SUTC) employees and patients. A barrier to TFWP adoption is anticipated concerns from various stakeholders. This study examined changes in employee-anticipated concerns arising from fellow staff, patients, and community members, from pre- to post-TFWP implementation, using Chi-square/Fisher's exact tests. Pre-implementation leadership concerns about TFWP rollout were examined as moderators in generalized linear mixed models. Overall, 452 employees and 13 leaders provided data from 13 Texas SUTCs serving >82,000 patients yearly. Results indicated: 1) Employees thought most concerns would arise from patients, followed by staff and the community; 2) Anticipated concerns from staff decreased from pre- to post-TFWP implementation; 3) In SUTCs with pre-implementation leadership concerns, anticipated staff and patient concerns each significantly decreased over time; while anticipated patient complaints increased in SUTCs without leadership implementation concerns. Leadership concerns may compel greater preparation that leads to smoother TFWP rollout.

## **An Analysis of the Evolution of White House Bioscience and Health Policy Through PCAST Reports**

Soumya Somani | Mentor: Kenneth Evans

Each U.S. president appoints a group of preeminent scientists and industry leaders to the President's Council of Advisors on Science and Technology (PCAST), a committee that advises the president on federal science policy through public reports and meetings. This study presents a thematic analysis of 15 PCAST health policy reports to understand how White House policy on biomedical issues changed with time. Through qualitative textual analysis, specific themes were identified in each report and tracked across reports and administrations. Such analysis revealed a shift over the past thirty years from a focus on basic research to an emphasis on applied research. The intended audience also gradually expanded from the government to include stakeholders in industry and academia. The increasing inclusion of public health topics and references to politics was also observed. The increasing diversity of audiences and priorities indicates that federal bioscience policy has become more complex over time. A notable dearth of focus on health equity and civic science across the reports indicates that PCAST could potentially broaden its approach to health policy to address emerging concerns.

## ***Exploring the Future of Anti-Trafficking Work: Evaluating Demand-Side Anti-Trafficking Program Success***

Sarah Sowell | Mentor: Morgan Kinney

In a mixed-methodology study partnering with the organization Demand Disruption (DD), I evaluated their STAR class to understand if demand-side programming is successful in decreasing sex trafficking. Analysis focused on DD's STAR class, which educates men convicted of buying sex of the exploitation present in the commercial sex industry as well as provides support and mentorship. This model is considered 'demand-side' as it focuses on decreasing sex trafficking by decreasing the demand for commercial sex. To understand the context of sex buying, interviews previously conducted by DD with sex buyers were thematically coded and analyzed. Using data collected by DD, success among participants was then evaluated, operationalized by an understanding of human trafficking, participant well-being, and decreasing reported desire to buy sex. Success was further evaluated in subgroups to test for implicit bias in programming. All participants gave informed consent, and privacy was protected. The study found that the program is successful in all metrics among most subgroups and shows little indication of implicit bias, pointing to this model's promise in decreasing trafficking.

## **The effects of attention and learning on episodic memory performance**

Aditi Velgekar | Mentor: Fernanda Morales Calva

Episodic memory, the capacity to encode, store, and retrieve information about personal experiences, relies on the hippocampus and surrounding structures. Whether or not an element is remembered is reliant on many factors including attention and memorability. Memorability is the inherent characteristic of a stimulus to be better remembered than others. Learning, attention, and memory are clearly intertwined. Discerning the nature of their interactions can have strong implications for the classroom setting. Links between learning styles, attention and attention disorders, and memorability have not been established. We developed a task that taxes episodic memory to measure performance through target recognition and lure discrimination. The former denotes one's ability to recognize a previously seen image while the latter denotes one's ability to distinguish between two similar images. We aimed to see the interactions between memory performance on a memorability-based task and potential correlations with attention measures and learning style preferences. Determining relationships that exist could elucidate potential improvements applicable to classrooms and curriculums.

## **Memories of Trauma: Material Deprivation and Psychological Distress Among U.S. Undocumented Latino Immigrants**

Jin Yan | Mentor: Luz Garcini

As of 2019, the U.S. had nearly 10 million undocumented immigrants, a majority of which are of Latino origin. Undocumented Latino immigrants may face structural inequity and pre-migration trauma, yet often lack access to health resources and feasible care. This project analyzed existing data from 253 undocumented Latino immigrants collected via Respondent-Driven Sampling. Specifically, the study assessed the relationship between material deprivation and depression and anxiety using religiosity as a potential moderator. Approximately 49% of respondents reported a history of material deprivation,

and 22% and 16% reported clinical levels of depression and anxiety, respectively. Standard multiple linear regression revealed that material deprivation significantly predicted depression after controlling for relevant demographics,  $\beta = 2.73$ ,  $p < 0.001$ . In a subsequent regression model, material deprivation also significantly predicted anxiety,  $\beta = 3.09$ ,  $p < 0.001$ . Results from this study can help inform intervention and advocacy efforts aimed at addressing the mental health needs of undocumented Latino immigrants.

### ***Protecting Immigrant Parents: Income Insecurity and Psychological Distress Among Undocumented Latino Parents***

Michelle Yang | Mentor: Luz Garcini

Income insecurity is a salient compounded stressor to parental mental health, and it is associated with increased symptoms of psychological distress. Such relationships, however, have yet to be explored among undocumented Latino immigrant parents. This cross-sectional study will use data collected through respondent-driven sampling from 219 undocumented Latino parents in the U.S. to examine the relationship between income insecurity and overall psychological distress. In addition, we will examine English language proficiency as a moderating variable to this association. It is hypothesized that income insecurity will be strongly positively correlated with symptoms of psychological distress, and English language proficiency will reduce the strength of this association. Multivariate regression analysis will be used to evaluate the hypothesized associations after controlling for relevant socio-demographic covariates. Protecting the wellbeing of undocumented parents is needed to ensure better home environments in which children can thrive, and results from our study will shed further light on the unmet economic and mental health needs within this overlooked population.