The Office of Undergraduate Research and Inquiry presents

OURI

Seeing the World Through Different Lenses

RICE UNDERGRADUATE RESEARCH SYMPOSIUM

2020

Abstract Book

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Letter from the RURS Co-Chairs

Hello all,

We are thrilled to present to you the abstract book for the 2020 Rice Undergraduate Research Symposium (RURS). These pages contain an abundance of Rice undergraduate research from across numerous disciplines, showcasing the scholarship happening across campus. For almost twenty years, RURS has served to provide a platform for undergraduate researchers to exchange knowledge and get students excited about the numerous possibilities for inquiry that are available to them. Research enhances the undergraduate experience by allowing students to explore beyond the classroom and to grow as individuals and leaders and such work deserves a place to be recognized.

Our theme for this year was "Seeing the World Through Different Lenses." When we adopted this theme, our goal was to honor all the different forms research could take and celebrate the different perspectives each field provided for examining our world. We wanted to stress that research was something anyone could accomplish, regardless of major or year. Our experiences shape the way we view the world, and each new lens provides additional insight into our lives, helping to illuminate the answers we all seek.

In the face of unprecedented circumstances, the RURS team reflected inward as we examined RURS through an entirely new lens. As we transitioned to a format that would ensure RURS 2020 was possible, we wanted to ensure we preserved the spirit of the symposium. At its core, RURS is an event for undergraduates across campus to showcase their research, gain presentation experience and feedback from experts in their field, and celebrate what they had accomplished. We felt it was important to ensure that RURS remained open to whoever wished to participate and honored the work and effort of undergraduate researchers. We hope amongst all of the changes made to ensure this event could continue, you feel we honored this tradition.

We would like to thank all of the faculty, students, and staff who make RURS possible. Additionally, we extend our sincerest gratitude to the mentors from within Rice and beyond who tirelessly promote undergraduate research, support student scholarship, and provide opportunities for inquiry.

Sincerely,
Alison Drileck and Anika Sonig
RURS Co-Chairs 2020

Office of Undergraduate Research and Inquiry

Stay involved with OURI! Read about some highlighted undergraduate research programs at Rice and learn about additional opportunities at ouri.rice.edu.

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.

Student Opportunity Center
The Student Opportunity Center is a searchable database for experiential opportunities including internships, publications, research positions, scholarships, and symposia. In addition to offering opportunities available nationwide, the site allows you to filter opportunities only open to Rice students. Every Rice undergraduate has access to the system. To activate your account, enter your Rice email account that uses your netid and press login.

Bowl of Rice Podcast
Bowl of Rice tells the story of Rice University undergraduate researchers and scholars. In each episode, you'll hear from a student about their project and next steps for academic, professional, or research plans. Host Brendan Wong is a Sociology and Ecology and Evolutionary Biology double major. He is also a bit of a foodie, so he'll also ask students about their favorite food in Houston. The podcast name Bowl of Rice pays a nod to this question, but also represents how each student engaged in research, design, and creative work at Rice come together in the recipe of Rice undergraduate inquiry.

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.

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.

Rice Undergraduate Student Journals

Rice University has a number of student publications that promote the research and creative work of Rice's Undergraduate population

Plat: https://www.platjournal.com/
R2, The Rice Review: https://www.r2ricereview.com/
Rice Asian Studies Review:https://chaocenter.rice.edu/students/rasr
Rice Catalyst: http://ricecatalyst.org/
Rice Examiner: https://riceexaminer.rice.edu/
Rice Historical Review: http://www.ricehistoricalreview.org/
Rice Journal of Public Policy: http://bisf.bakerinstitute.org/rjpp

Conference Funding
Juniors and senior students who are attending a conference to present research or design are eligible to apply for conference funding. Students, both individuals and teams, can apply for up to $500 to support either travel or registration costs.

Distinction in Research and Creative Work
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.

Outstanding Undergraduate Research Mentor Award
The Outstanding Undergraduate Research Mentor Award honors individuals who demonstrate exemplary mentorship to Rice undergraduate students in research, design and creative works projects. The Office of Undergraduate Research and Inquiry accepts nominations from current Rice students who would like to acknowledge the impact their research mentor has had on them and their experience.

ENGINEERING

Bioengineering and Biomaterials

ENGI 1: *Development of user controlled blood flow modeling device for testing low-cost Blood Perfusion Imaging system*

Franklin Briones

Mentor: Dr. Ashutosh Sabharwal

Abstract: Measurement of blood perfusion is critical for the diagnosis of injuries. Current methods are expensive and not easily accessible. A team at Rice University created the PulseCam, a simple, low-cost device to map perfusion. Preliminary testing must be performed on a skin phantom to ensure effectiveness of PulseCam. In our lab we will be creating a user-controlled device to propagate blood through a skin phantom in a physiologically relevant manner. The blood movement is controlled by a pump whose system will be optimized to ensure ease of adjustability. Our testing plan includes developing software for an Arduino that will continuously alter flow parameters such that it will move blood through the phantom replicating blood flow below the surface of the skin. The electronic control signals will be conditioned for increased accuracy of modeling. Additionally, a user interface will be created in C++ to allow a user to control the pump from a PC. As a result of the development of this blood flow modeling system, the PulseCam can be tested for efficacy on a non-living sample. In the future we intend to include additional parameters in the control system mimicking disease artifacts.

ENGI 2: *Elucidating the Role of Androgens in Calcific Aortic Valve Disease Progression in Porcine Aortic Valvular Interstitial Cells*

Alexander Curylo

Mentor: Dr. Jane Grande-Allen

Abstract: Calcific Aortic Valve Disease (CAVD) is a degenerative cardiovascular disease affecting 2.5+ million people in the developed world in the year 2000 and rising. Prior studies have indicated sex-linked differences in genetic expression of CAVD associated markers in aortic valve leaflets. Our work has focused on further examining these differences, particularly as they relate to the role of

androgens, with a focus on Testosterone (T) in particular. Our work has shown a complex relationship between T and cellular proliferation in both male and female Valvular Interstitial Cells (VICs), with certain low concentrations of T increasing cellular proliferation. Current RT-qPCR data does not indicate any significant difference in either androgen receptor (AR) or alpha-smooth muscle actin. Our work elucidates that, while likely still an effective human analog, porcine VICs may not show a complete picture when used for studying CAVD.

ENGI 3: *Using Hydrogel Coatings to Alter Heart Valve Surfaces*

Romi Lee

Mentor: Dr. Jane Grande-Allen

Abstract: Glutaraldehyde fixation of bioprosthetic valve replacements (BPVs) results in protein adhesion and calcification on the tissue's surface. Calcification limits BPV lifespans to 10 - 15 years. Repeated surgeries to replace these failing implants are not only costly but also increase rates of morbidity and mortality. Extending the lifespan of these valves is necessary to improve patient quality of life. Our previous work has found that the hydrogel poly(ethylene glycol) diacrylate (PEGDA) as a coating for valve surfaces limits protein adhesion. However, poly(ethylene glycol) diacrylamide (PEGDAA) may be preferable for coating valves due to greater long-term biocompatibility which may further extend BPV lifespans. Here, we compare the similarities and differences between PEGDA and PEGDAA hydrogel coatings on BPVs with regard to mechanical properties and degradation to determine fitness for future implantation. We have found that PEGDAA-coated BPVs have reduced protein adhesion similar to PEGDA-coated. We have also found that both coatings revert mechanical properties back towards unfixed tissue. Based on these results, PEGDAA is a suitable candidate to limit protein adhesion on BPVs.

ENGI 4: *Wireless Battery Charging via Magnetoelectric Films for Neuroengineering Applications in Freely Moving Animals*

Alexander Li

Mentor: Dr. Jacob Robinson

Abstract: Neural recording and stimulation are critical to the study of neural processes and the diagnosis and treatment of neurological disorders. These systems can be powered wirelessly to allow natural animal behavior and reduce experimental interference, with the predominant strategies involving inductive

coupling or an on-board battery. Inductive coupling struggles to deliver sufficient power at small sizes and weights, while replacing batteries can disrupt long-term experiments. Recently, magnetoelectrics (ME), which couple magnetostrictive and piezoelectric materials, have shown increased power delivery in small-scale devices relative to inductive coupling. However, when a magnetic field cannot be maintained near the subject, the device must store energy to preserve function. Here, we show a proof-of-concept system coupling a ME film with a rechargeable battery for integration with animal home cages to perform chronic, automated experiments. We also suggest improvements to charging optimization and variation in experimental setups, such that future iterations of this system will allow greater flexibility in chronic wireless neural recording and stimulation in freely moving rodents.

ENGI 5: *Using machine learning to identify important residues for transfering tropisms between capsids of different Adeno-associated viral vectors*

Hoang-Anh Vu

Mentor: Dr. Junghae Suh

Abstract: Adeno-associated viruses (AAV) have been proved to be a very promising vector for gene delivery, due to multiple reasons, including a very mild immune response's elicitation, as well as stable and predictable integration into specific sites on human chromosomes. However, there are various limitations with their applications right now, one of which is the difficulty in using repeated dosage of the same recombinant virus vector due to immunogenic response. The Residue Importance Processing (RIP) project aims to enhance AAV9 serotype 9's (AAV9) ability to transduce HEK293T cells, derived from human embryonic kidney cells. AAV9 is known to be very effective *in vivo*; however, for reasons that are not completely understood, its performance *in vitro* is lacking compared to other serotypes such as AAV2. By using machine learning, we extracted the promising residues on the AAV capsid genome that differentiate more efficient serotypes at transducing HEK293T cells from less efficient serotypes. We then mutate those residues on wild-type AAV9 to investigate whether there is an appreciable improvement in transduction ability of the recombinant AAV9.

ENGI 6: *High Resolution Targeting of Brain Regions with Ultrasound-Enhanced Gene Delivery*

Joycelyn Yiu

Mentor: Dr. Jerzy Szablowski

Abstract: The blood-brain barrier (BBB) is necessary to maintain the environment required for proper neuronal function. Although the BBB has necessary biological functions, it impedes the passage of pharmaceuticals. We proposed to develop a method that will allow for the targeting of microscopic regions in the brain through the BBB with Acoustically Targeted Chemogenetics (ATAC). Previous research has shown that functional gene expression in Cre transgenic mice can be achieved through delivering the gene editing target, a floxed genetic element. We will work on using molecular genetics to improve the targeting precision of ATAC.

Civil and Mechanical Innovation and Materials Research

ENGI 7: *Selective Electrosorption (SES) Technology for Brackish-water Desalination*

Jonah Ban

Mentor: Dr. Ibrahim Abdallah

Abstract: Selective Electrosorption (SES) is a selective ion-removal process based on applying an electrical potential difference across an aqueous solution that flows in between nanocomposite porous electrodes (e.g. coating of ion exchange resin particles over porous electrodes). The porous electrodes consist of selective ion exchange resins on the surface of a carbon electrode. Ions are adsorbed in the electrodes and a product stream with a reduced salt/ion concentration is obtained. A novel cylindrical SES pilot-scale unit has been designed and developed to accommodate multiple pairs of cells (consisting of electrodes and membranes) to desalinate brackish water. Through SES experiments, the mechanism of desorption and adsorption has been investigated by measuring the effluent pH, conductivity, and temperature.The pH of the effluent solution varied significantly with a change in the electrical potential. The removal efficiency of the salt increased with increasing the electrical potential at the range of 0.5–1.5 V. The removal efficiency was reported to be 80% and 19% for 1.5 V and 0.5 V, respectively, while the water recovery was 60%.

ENGI 8: *Engineering Thermo- & Photo-Responsive Fluidic Pumps using Liquid Crystal Elastomers*

Sueda Cetinkaya

Mentor: Dr. Rafael Verduzco

Abstract: Liquid crystal elastomers (LCEs) are loosely crosslinked polymer networks with unique optical, mechanical, and physical properties that enable them to shape-shift with thermal stimuli. These unique elastomers have a nematic phase where the liquid crystalline molecules have orientational order at low temperatures and an isotropic phase where there is no order at elevated temperatures. Recent work demonstrated that dual-network LCEs can be cured in the isotropic state, and shape programmed in the nematic state through UV curing. When heated above or cooled below the nematic to the isotropic transition temperature, TNI, the LCE can reversibly shapeshift between the cured and programmed shape. We attempt to expand the potential applications of LCEs by making self-pumping fluidic devices. We program an LCE device to have a collapsible fluidic channel capable of pumping water in response to higher temperatures. In addition, we expand current chemistries to include a photo-responsive dye and additional monomers to produce LCEs with tunable TNI values. The resulting pumps can be controlled using a cascading laser or uniform heat source to yield a bidirectional or one-directional pumping.

Computer and Information Science and Engineering

ENGI 9: *Markov Decision Process Policy Synthesis for Multi-Modal Planning*

Thomas Herring

Mentor: Dr. Lydia Kavraki

Abstract: A novel planning framework for robotic motion that learns to guide searching between modes of interacting with objects and environments. The framework uses both online and pre-computed offline information to guide searches based on prior experience. By using a Markov Decision Process to reason about transitions between modes, we can gain an heuristic understanding of which transitions are likely to succeed. This implicit understanding gives the planner a sense of affordances for objects and environments that rivals how humans interact with the world. Additionally, by incorporating an online weighted transition graph with these experience-based weights, we can enrich planning in more difficult and novel environments.

Electrical Communications and Cyber Systems

ENGI 10: *Computer Vision for Braille Reading Analysis*

Devon Merz, Tiger Yang, Aryan Sefidi, Collin Allen, Travis Shivers

Mentor: Dr. Robert Englebretson

Abstract: The aim of our project is to eliminate the technological gap between eye-tracking software for the sighted and finger-tracking software for the visually impaired. Existing methods designed to address this problem lack both accuracy and reproducibility. Our group has developed a novel solution to this issue, employing computer vision software to track Braille readers' fingers. Computer vision has been used extensively for optical pupil tracking, but so far these technological advancements have not been adapted to the field of Braille research. By developing this system, we will provide valuable data to Rice professor Dr. Englebretson as well as to other researchers that would benefit from our open-source project.

Mathematical and Physical Sciences

ENGI 11: *Estimating Benefits for Decision-Making With Multiple Goals*

Alexander Dunbar

Mentor: Dr. Andrew Schaefer

Abstract:People must make decisions every day. Many of these decisions are beneficial or costly to multiple goals that a person may have. Consider, as an example, the decisions that a backpacker must make while planning their trip. When planning what food to carry, they would want to maximize the number of calories they bring with them while also maximizing the amount of protein they bring. Throughout this process, they must also ensure that they do not pack more weight than they can carry. This problem, as well as similar problems, can be modelled with a rigorous mathematical framework. Using that framework, we develop approaches for estimating the maximum benefit that can be gained.

HUMANITIES

Creative and Performing Arts

HUMA 12: *Exploration on Music's Capacity to Heal through Connection and Resilience*

Debora Kim

Mentor: John Mulligan

Abstract: Music therapy is a useful sign post for wellness envisioned by a robust humanistic medical framework. However, its current reduction as a "humanistic supplement" to the biomedical model imposes limitations on the therapeutic capacity of music. This project allows music to articulate its potential to heal in its own terms. Scholars have approached music and wellness by various perspectives: music as a way to increase engagement, empower the oppressed, enhance mind-body health, and create access to transcendence and overcoming. This project strives to understand these viewpoints on the therapeutic effects of music through the lens of two related concepts, connection and resilience. Connection has been linked to spirituality as the means through which one develops a relationship with the self, the other, the environment and the transcendental. Resilience has been defined as the capacity to engage in suffering and cope with trauma. I present a synthesis of literature revealing music's power to connect and build resilience. Additionally, I incorporate interviews from experts who give insights into the therapeutic potential of music in their own fields which intersect music and medicine.

History and Cultural Heritage

HUMA 13: *The Socioeconomic Distribution of Visitors at the Moody Center for the Arts*

Grace Chialiva

Mentor: Dr. Laura Heath-Stout

Abstract: The question of low-income accessibility in museums has been a prominent topic in museology for the past 20 years. While museums have attempted to increase accessibility for low-income families and individuals, there are still future improvements to be made. My paper addresses the issue of accessibility in museums with special attention to economically disadvantaged zip

code regions in Houston, centering on a case study, the Moody Center for the Arts. Specifically, in my project, I created ArcGIS Pro maps using Moody visitor zip code data and 2010 U.S. Census median household income data in order to show the socioeconomic distribution of Moody visitors in Houston. I argue that since Moody has free admission and events for the public, it is more accessible than comparable ticketed museums; however, financial burdens still exist for visitors, such as transportation and parking. In conclusion, this project closely examines Moody visitor zip code data, ArcGIS Pro maps, and median household income for Houston zip code areas, in order to shed new light on the neglected issue of low-income accessibility in museums.

HUMA 15: *Pioneering Democracy: Race and Gender in Suffragist Print (1865 - 1920)*

Sumin Hwang

Mentor: Dr. Laura Heath-Stout

Abstract: My project pays close attention to the intersections between White suffragists, African-American maleadvocates, and African-American female suffragists through primary source materials to examine how each group navigated structures of oppression to diffuse their respective political priorities in the Reconstruction Era. I draw from the digital archives from the Library of Congress, the Modern Journals Project, and from the Houston Printing Museum's collection to dissect each group's advocacy by critically analyzing the interactions between Elizabeth Cady Stanton's The Revolution, W.E.B. Du Bois' The Crisis, and selections from Mary Church Terrell's vast body of work. I argue that many White suffragists revealed their unfortunate racism in their opposition to the 15th Amendment and that the advocacy of both African-American men and women shifted in response to this racism, balancing the need to appease a plurality of audiences to achieve political equity. This research culminates in a digital media project to be installed at the Houston Printing Museum with the goal of introducing a more intersectional approach to their Woman in Print: Advancing Women's Suffrage gallery.

HUMA 16: *The Role of the Familiar Spirit in the Glanvill-Webster Witchcraft Debate*

Jason Lee

Mentor: Dr. John Mulligan

Abstract: *The Displaying of Supposed Witchcraft* by John Webster, a skeptic of witchcraft, was published during the late 1600s in Restoration England as a

response to *A Blow at Modern Sadducism* by Joseph Glanvill, a believer in witchcraft. This paper explores the scientific, religious, and political implications of the familiar spirit in the Glanvill-Webster debate. I begin by examining the fluid nature of the familiar spirit and propose that the familiar spirit was underemphasized in the discussions of the Glanvill-Webster debate due to the inconsistency of beliefs surrounding its essence and variety of terms used to describe it. I then propose that the corporeal nature of the familiar spirit was likely critical in motivating Glanvill and Webster to supplement their arguments of witchcraft with scientific theories such as the poisonous vapors theory. Highlighting the popular nature of the familiar spirit, I further argue that Glanvill was politically motivated to argue for the existence of witchcraft. In particular, Glanvill appeared to be using sadducism, which he equated to atheism, as an integrative device to unite certain religious factions with the Anglican church.

HUMA 17: *Neocolonial Memories: Reconfiguring Indigenous Cultural and Socioeconomic Hegemony in the Andean Highlands*

Katie Nguyen

Mentor: Dr. Laura Heath-Stout

Abstract: Through a section proposal for Hall of Americas in the Museum of Natural Science, I will bring together a display, or rather, an active representation of Inka culture within the framework of epistemological decolonization and while centering ordinary experiences to counter the common conceptions of the Inka as merely grandiose and imperial. This will be partly done by focusing on non-Inka Andean communities and including the works of contemporary artists and activists that represent and advocate for indigenous cultural authority, hopefully providing complex insights to the role of natives physically and ideologically in contemporary society. Modern indigenous existence is not limited to physical presence, but rather, occurs in complex spatial, cultural, and ideological mechanisms that must constantly resist the powers of neocolonialism. Through a comprehensive representation of Andean highland civilizations that is rooted in research, organizations, and practices that center and prioritize indigenous writers, thinkers, and activists, the Museum of Natural Sciences will participate in a globalized movement to destabilize white power structures and its neocolonial apparatuses.

HUMA 18: *The Independent Publisher as a Tool for Social Reform and Community-Building*

Lily Wulfemeyer

Mentor: Dr. John Mulligan

Abstract: Mainstream publishing companies are inadequate at establishing progressive, ethical values, as the industry is dominated by culturally privileged voices. In focusing on Bloomsday Literary, a Houston-based publishing press and podcaster, this case study explores the niche role that independent publishers serve within their local and national communities to address issues of equity in the industry. Bloomsday's work poses a model, as they successfully grapple with critical industry questions such as: How can publishers center marginalized voices, and how can they participate in local community-building efforts? Most notably, Bloomsday seeks out writing that addresses urgent national issues; ensures that their authors are writing from personal knowledge and thus suited to speak on complicated subjects; and participates in local events, community organizing, and collaboration. Yet, like many indie presses, Bloomsday faces significant financial barriers. Local governments should consider financially supporting independent publishers as allies who increase engagement and employment opportunities in the local arts industry.

Other Works in the Humanities

HUMA 19: *The Effects of Exhibition Design on Museum Experience*

Xueyuan Wang

Mentor: Dr. Laura Heath-Stout

Abstract: Exhibition design involves the arrangement of exhibition spaces, regulating visitors' traffic, and the design of display furniture, which have both direct and indirect impact on manipulating visitor's experience during a museum visit. Aspects of exhibition design could reward communication of exhibit messages and visitor learning. This paper analyses how exhibition design strategies affect visitor experiences at the Nancy and Rich Kinder Building, a new construction that belongs to the Museum of Fine Arts, Houston (MFAH). Comparative research focusing on MFAH Kinder Building and selected art museums around the world addresses the visitor experience created through the museum's architecture design. Furthermore, the effectiveness of the museum's structural arrangement facility designed to counter "museum fatigue" will be

investigated. Understanding how museum and gallery design affect visitor's experience is not only vital to museum institutions but to museum visitors as well. This paper aims to foster that awareness through the case study on the Nancy and Rich Kinder Building.

HUMA 20: *Meaning-Making through Optimism and Despair at the End of Life*

Lillian Wieland

Mentor: Dr. John Mulligan

Abstract: The end of life process represents an important opportunity for meaning-making, but the biomedical model denies the opportunity for this meaning by misinterpreting the significance of optimism and despair through its focus on curing. I aim to reframe our values surrounding optimism and despair so people do not stagnate and fail to move on to "hope," where they can make meaning. I reviewed literature and conducted interviews with psychiatrists, chaplains, patients, and community members to reveal this dialectic, though inverting the typical connotations. For example, despair was not bad, but necessary to feel intense emotions surrounding the dying process, and optimism was not good primarily when it shut down emotions and thoughts related to dying. I anticipate that going through both despair and optimism in a recursive process helps patients and community members make the most meaning of their lives. By examining dying as a recursive process of meaning-making rather than a linear progression toward death, we as a society can be more present for, rather than ignore, the process of dying which inevitably results in the loss of our loved ones.

NATURAL SCIENCES

Bioengineering and Biomaterials

NSCI 21: *Design of Bone Regenerative Material Systems using Growth Factor Delivery Vehicles*

Panayiotis Kontoyiannis

Mentor: Gerry Koons

Abstract: One of the challenges with bone regeneration is the attraction and guidance of local cells and cellular machinery to aid in osteogenesis and bone repair. Regeneration can be stimulated through the use of bioactive molecules and therapeutic proteins. However, in tissue engineering, there is an additional challenge in the creation of scaffolds that can both precisely and safely deliver these molecules to the body in order to stimulate regeneration and growth. Often these growth factors can become denatured by temperatures needed to incorporate them into a scaffold. Additionally, if these proteins are safely delivered into the body, there is not a guarantee of the proteins remaining localized to the specific site of injury.

Thus, a model was designed to incorporate and preserve bioactive molecules in a tunable and 3D printed bone scaffold. The created design involves the encapsulation of a growth factor, bone morphogenetic protein 2 (BMP-2), in nano/microparticle poly(D,L-lactic-co-glycolic acid) (PLGA) delivery vehicles within a synthetic polymer poly(propylene fumarate) (PPF) scaffold that can be 3D-printed.

NSCI 22: *Energy Efficient Self-Sterilizing Laser-Induced Graphene Air Filters*

John T. Li

Mentor: Dr. James Tour

Abstract: Numerous pathogens responsible for healthcare-associated infections (HAIs) are prevalent in hospitals, which may spread through HVAC systems. Airborne pathogens are difficult to contain, and room-to-room spread is common. Filtration is a popular strategy to remove the pathogens, particles, and products of microorganism destruction that may have resulted from the usage of disinfection strategies. Here, we demonstrate a self-sterilizing laser-induced graphene (LIG) filter that is shown to capture particulates and bacteria. The filter was formed through simple direct writing with a commercial laser cutter, which allows for

easy scalability of the process, and the porous graphene was able to suppress bacterial proliferation, despite being soaked in culture medium. Through periodic Joule heating, the microorganisms, along with biomolecules that may cause negative immune responses were eliminated. The recommended application of the filter is in hospitals, to reduce the risk of nosocomial infections.

Chemical Biological and Environmental Systems

NSCI 23: *Elucidating the Connection Between Histone H3.3 and Pediatric High-Grade Glioma*

Natalie Gault

Mentor: Dr. Jian Hu

Abstract: Common mechanisms by which a cell transforms into a cancer cell usually involve members of the signal transduction cascade. These so-called oncogenes, such as cell-surface receptors or downstream targets, drive cells to deviate from normal functioning. Pediatric High-Grade Glioma (pHGG), one of the deadliest cancers in children, defies this usual occurrence. pHGG has been linked to mutations of histone H3.3, making pHGG one of the first cases of oncohistones. Because oncohistones have only recently been discovered, there is little understanding on this cancer transformation. Histones are crucial to epigenetic regulation, so it is unclear how something so global can cause cancer. However, these mutations are believed to lead to cancer through aberrant PTM modifications, which then affect global gene expression and cause abnormal cell functioning. Because the mechanism underlying oncohistone cell transformation is unclear, there is insufficient understanding of pHGG, and its prognosis is poor with few therapy options. Using a mouse model of H3.3 G34R, ATRX, and p53, this project aims to elucidate the mechanism from H3.3 G34R to cancer, focusing on proliferation and differentiation.

Environmental and Earth Sciences

NSCI 24: *Chemical Analysis of Altered Stimson Sandstones on Mars*

Madison Morris

Mentor: Dr. Kirsten Siebach

Abstract: The Martian Stimson sandstones were chemically and mineralogically analyzed by the Mars rover, Curiosity, and contain clear unaltered and altered

relationships. The goal of our project is to further understand how these sandstones were altered by tracking the chemical and mineral transitions between the corresponding altered and unaltered samples. Using the data collected from Curiosity's Chemistry and Mineralogy X-ray diffraction instrument (mineralogy of two altered and two unaltered sites) and the Alpha Particle X-ray Spectrometer (chemistry of sixteen altered and sixteen unaltered sites), we have calculated the percent change of each element between altered and unaltered samples. We aim to understand the variability in the sandstone by plotting variations in MATLAB to track when changes are specifically related to the alteration episode. We began by graphing all the sample chemical compositions and their standard deviations against SiO2 and CaO in MATLAB to understand how the calcium and silica evolved during the alteration process. Moving forward, we plan to continue the specific analysis of these elements to clarify the process of how the sandstones were altered.

NSCI25: *Using Drone Photogrammetry to Detect Change over Time in Houston and Aid in Flood Mitigation*

Jessica Sheldon

Mentor: Dr. Kirsten Siebach

Abstract: Drone technology and the high resolution datasets it enables stand to revolutionize our understanding of the Earth's surface. My research is Houston specific, and studies how we can use drones to collect photogrammic data to detect environmental changes, and how that data can be used to mitigate flooding in high risk areas.

This project is a three year research project, and we are currently in year two. Leading up to this, the team has developed a workflow for drone image collection and data processing using a DJI Phantom 4 Pro for collection and a combination of Pix4D and ArcGIS for processing and mapping. The research presented today will focus on case studies showing ways drones have been used in Houston and elsewhere to detect environmental changes relevant to flood prevention, as well as ArcGIS maps of Houston's change over time.

The data used for these maps is publicly available images. We developed elevation models, and then overlaid them in ArcGIS to create a difference map that indicates where elevation change has occurred in the area. We plan to use this information to detect areas of intense change to then fly the drone over and develop high resolution models.

Environmental Biology

NSCI 26: *Measuring the role of geography and ecology on the hyper-diverse natural enemy community associated with the gall wasp Disholcaspis quercusvirens*

Shih-an Shzu, Linyi Zhang , Pedro Brandao, Scott Egan

Mentor: Dr. Scott Egan

Abstract: One major goal in ecology is to identify the processes that increase, maintain, and decrease biodiversity. Although geography and host plant-affiliation are potential drivers of community composition in plant-insect systems, their relative importance is not yet fully understood, especially in hyper-diverse oak-gall wasp-parasitoid communities. Here, we test the association of geography and host-plant affiliation on the natural enemy community of the gall-forming wasp *Disholcaspis quercusvirens*. We sampled 15 populations across Florida, U.S.A., on two different host plants, *Quercus geminata* and *Q. virginiana*, that overlap in geographic range but differ in microhabitat. In all, 1500 natural enemies were detected and separated into 37 putative species based on morphology. Out of 37 morphospecies, 13 were found only on one or the other host plant, while 24 were shared between them. Differences in community composition between populations co-varied more with geography (Mantel, $p=0.51$), than host plant ($p=0.73$) Together, these results suggest that geography may be more important than host-plant affiliation in structuring the natural enemy community of *D. quercusvirens*.

NSCI 27: *Analysis of the Seed-to-Coating Ratio of Triadica Sebifera*

Dustin Ho

Mentor: Dr. Evan Siemann

Abstract: The Chinese Tallow Tree *Triadica sebifera* is a notable invasive species in the southern United States. It threatens local biodiversity by secreting toxins in its leaves which alter the soil chemistry when dropped. The tree was originally imported because its seeds contain a waxy coating suitable for soapmaking. When the seeds are consumed by birds, the coating is dissolved before the seed is excreted out in bird droppings, with a greater amount of coating theoretically leading to greater dispersal ability. However, investing resources in the coating to improve dispersal distance may have tradeoffs against investing in the seed to provide nutrition for offspring.A comparison of seed mass with and without the waxy coating needs to be carried out to see whether trees tend to optimize

reproduction, dispersal, or both. Seeds were collected from various populations across the southeastern United States and weighed to compare the seed-to-coating ratio. The results of this study show that there is variation in seed size and seed-to-coating ratio across populations, and as this study continues, a trend may become evident between different years.

NSCI 28: *Coral predators disperse abundant and diverse live coral symbionts*

Kristen Rabbitt

Mentor: Carsten Grupstra

Abstract: Corals are animals that rely on symbiotic microbial algae for food from photosynthesis. Different species of coral symbionts have distinct characteristics and provide benefits to the coral in different environments. However, how coral symbionts disperse between coral colonies and populations is unclear. We set out to test whether coral predators such as butterflyfishes, parrotfishes and filefishes may aid in the dispersal of coral symbionts. We collected fecal samples from seven coral predator species (n=6-13) and two non-coral predators (n=6-8) on Moorea, French Polynesia in July 2019. We then characterized the viability, abundance and diversity of coral symbionts in these samples. Obligate coral predators passed live coral symbionts at densities of up to 10 million per ml feces. Coral symbiont communities in feces were highly diverse and differed between predator species with different diets. Together, these findings may suggest that coral predators are important dispersers of coral symbionts and may thereby fulfill an important role in maintaining coral reef resilience.

NSCI 29: *Assessing the Impact of Hyposalinity Stress on the Coral Holobiont*

Kelsey Sanders

Mentor: Dr. Adrienne Correa

Abstract: Climate change is increasing the frequency of heavy rainfall, flooding, and terrestrial runoff events, all of which generate hyposalinity stress on coral reefs. This study addressed the impact of hyposalinity stress on the coral holobiont—the coral host and its associated microbes, many of which perform functional roles—via a tank-based experiment examining coral fragments under control and stress conditions over time. Visual assessments showed that some corals displayed higher rates of mucus production and mortality, suggesting considerable disparities in the resistance of coral species and genotypes to hyposalinity stress. Photosynthetic efficiency of coral photosymbionts (family

Symbiodiniaceae) did not appear to be significantly reduced in response to stress, as measured by PAM fluorometry. High throughput sequencing of bacterial 16S rDNA suggested that there are not strong community changes linked to hyposalinity stress despite shifts in key taxa abundances. Greater understanding of how environmental stressors impact host-microbe relationships will aid in future conservation efforts by shedding light on possible factors tied to resilience and resistance to stress.

NSCI 30: *Transgenerational impacts of nitrate enrichment on vertically-transmitted symbiont communities in the stony coral, Pocillopora acuta*

Jordan Sims

Mentor: Dr. Adrienne Correa

Abstract: Coral reefs worldwide are increasingly exposed to nutrient excess due to anthropogenic run-off, leading to declines in coral health that may be associated with disruptions at the microbial scale. Shifts in microbial symbiont communities associated with excess nutrients have primarily been studied in adult colonies; however, nutrient conditions of parent colonies may influence the microbial composition passed vertically to larval offspring. Using an in situ nitrate-enrichment experiment of *Pocillopora acuta*, I tested the impacts of parental nutrient enrichment on the bacterial and dinoflagellate community composition of individual larvae to improve our understanding of factors structuring symbiont communities in early coral life stages. Dinoflagellate communities were highly similar regardless of life stage or nutrient environment. Bacterial communities were more variable in nitrate-enriched parents, yet this pattern was not detected in larvae. This work will ultimately improve our understanding of the transgenerational consequences of coastal nutrient inputs on coral-dinoflagellate-bacteria interactions, an understudied but potentially important aspect of coral mutualisms.

NSCI 31: *Comparing pollinator and plant communities in two coastal prairie restorations and a prairie remnant in Houston, Texas*

Kathy Yu

Mentor: Dr. Evan Siemann

Abstract: Coastal prairies are a rare subset of prairies located along the Gulf Coast, but most of the ecosystem disappeared and now most prairie studies are conducted in the Midwest. Recently, there have been efforts to restore and

document coastal prairies in Houston, TX. This flower-filled ecosystem relies on mutualism between plants and pollinators, yet many restoration efforts focus solely on the plant community. This study will analyze the plant and pollinator community at two restoration sites with line transects and a no-capture method for pollinators. To assess effectiveness of restoration management, I will also compare data with a prairie remnant.

Human and Medical Lifesciences

NSCI 32: *Physical Strength Is a Factor Affecting the Success of Endotracheal Intubation*

Leenah Abojaib

Mentor: Dr. Shane Jenks

Abstract: Endotracheal intubation is utilized by emergency department physicians on patients who are unable to maintain the patency of their airway. Repeated attempts are associated with adverse clinical events, such as oxygen desaturation, aspiration, and cardiac arrest. Therefore, it is important to understand the factors affecting intubation to maximize the chance of a successful first attempt. While many studied factors are outside of the operator's control, a quality that is partially under the operator's control is physical strength, which can be improved by body strengthening activities. Thus, we studied the correlation between intubation success and physical strength, which was measured by individuals' ability to hold a 10-lb weight at a 90-degree angle from their body. Individuals who passed the physical assessment (n=25) and those who did not (n=19) intubated with different devices on mannequins that had an easy or difficult airway. The group that passed the physical assessment had a higher first-pass success rate although not within the realm of what we considered statistically significant, decreased number of intubation attempts, decreased intubation time, and better grade view.

NSCI 33: *Investigating How the Brain Encodes Syllable Information with Electrophysiology*

Zachary R. Murphy

Mentor: Colin Noe

Abstract:How humans comprehend speech despite tremendous variability in pronunciations and environments depends on a series of automatic and rapid transformations of acoustic information in speech. One key feature used to differentiate speech sounds is voice onset time (VOT) a measurement of the time

between the burst of the onset of a sound and start of the voiced segment (e.g. /d/ sounds have a short VOT and /t/ sounds have a long VOT). We can measure the VOT extraction process using an electrophysiological neural measure, the N100 event related potential. The VOT modulates the magnitude of the neural response. What is unknown is whether the N100 indexing VOT reflects the extraction of language specific cues or precursor auditory information processing. Thus, this study investigates this relationship of VOT and N100 magnitude. While we hold the linguistic feature constant, we manipulate the acoustic features of amplitude, rise rate, and spectral mean. This study informs the level of information that the neurons generating the N100 response are sensitive to. This will lead to an improved understanding of how the N100 response relates to neural processes.

NSCI 34: *Clinicopathological and Sociodemographic Prognostic Factors for Cervical Cancer in Georgia*

Ishaan Rischie

Abstract: Cervical cancer (CC) is one of the most widespread malignant carcinomas around the world. Though standard medical practice largely uses clinicopathological factors (CPFs) to determine patient prognosis, recent research has begun to uncover the prognostic potential of socio-demographic factors (SDFs), including age, race, ethnic origin, socioeconomic status, marital status, rurality, and health insurance status. This study evaluates the influence of these SDFs on CC survival and further compares the prognostic significance of SDFs with that of CPFs. Using the Surveillance, Epidemiology, and End Results (SEER) Program, 5,447 women diagnosed with primary invasive CC between 2000 and 2014 in Georgia were identified for this study. These CC patients were assessed for survival disparities with Kaplan-Meier survival analysis and Cox proportional hazards analysis. Statistically significant survival differences (p<0.05) were seen for all of the analyzed SDFs and CPFs. While the prognostic significance of CPFs is indubitable, this study reveals that there are significant socio-demographic barriers to CC treatment that could be addressed by healthcare policies to reduce survival disparities.

NSCI 35: *The Effect of Blood Flow Restriction Training on Rotator Cuff Strength in the Healthy, Untrained Shoulder*

Carter McKean Taft

Mentor: Dr. Bradley Lambert

Abstract: Blood Flow Restriction (BFR) training has become a common rehabilitation technique used to develop strength and muscle mass while using lower loads. Recent literature has shown that BFR resistance training increases cellular muscle fiber hypertrophy and lowers muscular atrophy following injury. This study evaluates the effects of an 8 week blood flow restricted rotator cuff training protocol on shoulder musculature, strength, and size in healthy, untrained subjects. 30 subjects were randomly assigned to either the experimental (BFR) or the control (noBFR) group and performed supervised exercise sessions 2 days/week for 8 weeks in both upper extremities with resistances adjusted weekly. Each group was measured before and after the program using force testing, DEXA scanning, 1RM testing and EMG rotator cuff activation. It is hypothesized that the BFR group would experience greater increases in rotator cuff strength, while inducing more activation of their rotator cuff muscles compared to the noBFR group. Findings from this study will be important to demonstrate an effective two month BFR rotator cuff training protocol for sports medicine professionals to use in practice.

NSCI 36: *OLFML3 Regulation of Microglia Infiltration in Glioblastoma*

Ashley Zhou

Mentor: Dr. Peiwen Chen

Abstract: Glioblastoma (GBM) is the most aggressive brain tumor in adults, consisting of glioma cells that survive, in part, through the recruitment and activation of immunosuppressive microglia into the tumor microenvironment (TME). Previous research has demonstrated that upregulation of the OLFML3 gene can increase the infiltration of microglia into the TME and increase GBM progression. However, the detailed mechanism of how OLFML3 promotes microglia migration is unknown. This project finds that OLFML3 may recruit microglia into the TME through activation of the GSKα/β pathway. A better understanding of how OLFML3 promotes microglia migration may lead to future therapeutic targets for GBM in the future.

Mathematical and Physical Sciences

NSCI 37: *Random Hamiltonians with Arbitrary Point Interactions: Positivity of the Lyapunov Exponent*

Mark Helman

Mentor: Dr. David Damanik

Abstract: We consider disordered Hamiltonians with arbitrary point interactions under minimal assumptions on the randomness. The Hamiltonians are given by the Laplace operator subject to random self-adjoint singular perturbations imposed on a random discrete set of points in the real line. However, contrary to all previously considered Kronig–Penney type random models, we make no assumptions on the regularity of the distribution of the i.i.d. random variables in question, which is essential in the study of several random quantum graph models. We managed to prove the following dichotomy: Either every realization of the random operator has a purely absolutely continuous spectrum or spectral and exponential dynamical localization hold. The core of such proof of Anderson Localization for those operators is our new result of the positivity of the Lyapunov exponent for all energies outside of a discrete set.

NSCI 38: *Improving Electron Identification using Artificial Neural Networks*

Anamitra Paul

Mentor: Dr. Frank Geurts

Abstract: The time-of-flight (TOF) detector in the STAR detector at the Relativistic Heavy Ion Collider (RHIC) has greatly improved our ability to study dielectron (e+e-) production in collisions between gold ions. However, background from misidentified light hadrons in certain kinematic regions shows detector responses similar to that of an electron, making electron or positron identification more challenging. We present a study comparing shallow and deep neural network classifiers for electron identification using data from the Time Projection Chamber (TPC) and TOF detector at STAR. Hyperparameter optimization for determining the optimal neural network architecture is presented, and these optimized networks are then compared with traditional cut-based PID techniques. We predict that deep neural networks will improve the sample purity rates in p+p collisions compared to other classification methods for electron identification. Such improvements will furthermore reduce backgrounds from misidentified electrons and positrons in dielectron spectra.

Molecular and Cellular Biology

NSCI 39: *Does a New Mutation in Perlecan Domain V Cause Kidney Stones?*

Vikram Aggarwal

Mentor: Dr. Mary Farach-Carson

Abstract: Perlecan/HSPG2 is a large, conserved multi-domain extracellular heparan sulfate proteoglycan. Loss of perlecan is lethal. A family with a single amino acid mutation in domain V of perlecan (A3943T) presented with idiopathic juvenile nephrolithiasis (kidney stones). No relationship between this mutation in perlecan and stone formation is known. Based on modeling, I hypothesize that the misfolded protein creates calcium nucleation sites, potentiating kidney stone formation as calcium travels paracellularly from nephron lumen to bloodstream. I first extracted and identified a primary renal epithelial cell line (ADRC) and defined the cell sub-type. In ongoing work, I am transfecting the normal and mutated gene into HEK293A cells and ADRCs and measuring calcification through an Alizarin Red S assay. If the mutated cells exhibit greater calcification, I will have established a correlation between A3943T and kidney stone formation, identifying a novel, non-lethal disease state for this perlecan mutation. This knowledge will highlight the importance of perlecan in proper kidney filtration and could help identify families with idiopathic nephrolithiasis.

NSCI 40: *Determining operon structure in Borrelia turicatae grown at 22 ºC*

Orlando Cervantes

Mentor: Dr. Job Lopez

Abstract: Tick-borne relapsing fever (TBRF) is a debilitating illness characterized by recurring febrile episodes, chills, nausea, and vomiting in humans. One causative species is *Borrelia turicatae*, which is transmitted by *Ornithodoros turicata* ticks throughout the southern United States and northern Mexico. Preliminary data indicates that *B. turicatae* differentially regulates its gene expression to survive in physiologically and immunologically different environment in the tick and vertebrae host. We have done some preliminary analysis of RNAseq data and have identified potential operons that are upregulated at 22 ºC. Therefore, these predicted operons may have an impact on tick vector colonization and adaptation for entry into mammalian hosts. My project this past year has been to determine if these potential operons are

expressed as a single mRNA transcript. The next phase would be determining if these operons are necessary for bacterial colonization of the tick vector and transmission to vertebrae. This study would illuminate an aspect of TBRF vector biology that has not been well-studied in the past and have an impact on development of intervention strategies against TBRF.

NSCI 41: *Thermoplant: Automated design of RNA thermometers for controlling the output of rhizobacterial enzymes that promote plant climate resilience*

Alicia Selvera, Claire Young, Samantha Cheng, Tasneem Mustafa, Stephanie Corona

Mentor: Dr. Beth Beason

Abstract: Recent changes in climate patterns pose an enormous threat to the agricultural industry. Increasing temperatures and lower soil water content systematically decrease crop yields. This project aimed to tackle this problem from the bottom up by engineering a common soil bacterium, *Pseudomonas putida*, to overexpress plant growth-promoting enzymes under a temperature-dependent system. *P. putida*, with its known root interactions with *Arabidopsis thaliana*, was utilized to promote plant growth through the production of indole-3-acetic acid (IAA), 1-aminocyclopropane-1-carboxylate (ACC) deaminase, and trehalose synthase. A program that couples genetic algorithms and NUPACK was created to design and optimize low-temperature RNA thermometers. Using molecular cloning techniques, necessary part plasmids were designed, implemented and tested in *E. coli*. Three of our RNA thermometers with melting temperatures of 30°C and one with a melting temperature of 37°C show promise for having better fold efficiencies than thermometers currently found in the iGEM registry. Maximizing crop yields now will ensure better food availability and distribution in the future.

NSCI 42: *pH Effects on Cell Growth and Red Fluorescent Protein Expression in E. coli*

Cody Clayhold, James Liu, Ridwana Islam

Mentor: Dr. Carrie McNeil

Abstract: The DsRed gene, which codes for Red Fluorescent Protein (RFP), is used to visualize gene expression1. This study sought to find a pH range that optimizes E. coli growth and RFP expression by measuring cell density at 600 nm (OD600) and absorbance at 591 nm of E. coli populations grown in solutions ranging from 5.5-8.5 pH. Both cell growth and RFP expression were predicted to be optimized at around neutral pH of 7.0. The OD600 absorbance data supported

the first prediction: cell growth peaked in the pH range of 7.0-7.5. The second prediction was initially supported by comparative qualitative analysis, which showed that the reddest liquid populations were around 7.0-7.5 pH. Scans of absorbance spectra for RFP showed two main peaks: one at 502 nm (corresponding with yellow wavelengths of fluorescence) and the other at 591 nm (corresponding with red wavelengths of fluorescence). E. coli grown in solutions of 7.0-7.5 pH expressed RFP with the highest absorbance at the 591 nm peak relative to the 502 nm peak, indicating a maximum red color and thus optimal RFP expression which also corresponded with the cell growth peak, confirming predictions.

NSCI 43: *IL-21 Increases Suppressive Functions of Myeloid-Derived Suppressor Cells and Inhibitory Macrophages*

Anna Cole

Mentor: Dr. Robin Parihar

Abstract: Adoptive immunotherapy using antigen-redirected lymphocytes in patients with solid tumors is hindered by immune suppressive cells such as inhibitory macrophages (M2s) and myeloid-derived suppressor cells (MDSCs) that contribute to a highly suppressive tumor microenvironment (TME). To promote their proliferation and function in TMEs, researchers have coupled redirected lymphocytes with stimulatory cytokines. However, the effect of these cytokines on MDSCs and M2s within the TME is unknown. We exposed human MDSCs and M2s to the common gamma-chain cytokines, interleukin(IL)-2, IL-7, IL-15, and IL-21 and assessed their phenotype and suppressive capacity. Exposure of human MDSCs or M2s to IL-2, IL-7, and IL-15 did not affect their cell-surface phenotype nor ability to suppress T-cell proliferation. In contrast, exposure to IL-21 increased their ability to suppress T-cell proliferation in a STAT3-dependent manner. Further, IL-21 exposed MDSCs and M2s inhibited tumor control by CAR-T cells in an in vitro TME model. Ongoing experiments will define the mechanisms by which IL-21 alters MDSC/M2 suppression and define the effect of IL-21-exposed MDSCs/M2s on CAR-T cell therapeutic efficacy.

NSCI 44: *Modulating phosphorylation of ATXN1's S776 as a therapeutic approach for SCA1*

Dany El-Najjar

Mentor: Dr. Huda Zoghbi

Abstract: Spinocerebellar Ataxia Type 1 (SCA1) is a dominantly inherited neurodegenerative disease characterized by motor incoordination and early lethality. It is caused by the expansion of CAG repeats encoding the polyglutamine (polyQ) tract in Ataxin-1 (ATXN1). The polyQ expansion stabilizes ATXN1 leading to its toxic accumulation in the brain. So far, no treatment options are available to prevent ATXN1's accumulation and neuronal degeneration. Previous studies identified phosphorylation at ATXN1's serine 776 (S776) as critical for ATXN1's stability. Given the importance of ATXN1 levels in SCA1, we sought out to investigate the potential of disrupting S776 phosphorylation to rescue SCA1 phenotypes *in vivo*. To do so, we mutated the serine to an alanine in a mouse model of SCA1. We found that disruption of S776 phosphorylation reduces ATXN1 levels and improves transcriptional changes associated with SCA1. Concordantly, behavioral tests showed an improvement in motor coordination and an extension in lifespan. These data highlight the importance of S776 phosphorylation on ATXN1 stability and emphasizes the potential for targeting it as a treatment option for SCA1.

NSCI 45: *Elucidating the Role of Peroxins in Pexophagy in Arabidopsis thaliana*

Abigail King

Mentor: Kathryn Smith

Abstract: Peroxisomes are essential membrane-bound organelles involved in sequestering reactions that produce toxic byproducts such as reactive oxygen and nitrogen species. The organelle relies on peroxin proteins for importing resident proteins. Peroxisomes can be degraded via a selective form of macroautophagy called pexophagy, but the triggers and receptors of pexophagy are unknown in plants. To elucidate the relationship between peroxins and pexophagy in Arabidopsis thaliana, we are crossing a mutant that prevents autophagy (*atg7*) with various peroxin mutants and characterizing the corresponding double mutants. We found that some double mutants had partially restored peroxisome function as monitored by plant hormone sensitivity assays. Additionally, western blot protein analysis revealed higher levels of peroxisomal proteins in double mutants and partially rescued import defects in select mutants. This elucidation of

the relationship between peroxins and pexophagy is useful in finding the mechanism(s) responsible for pexophagy and how these relate to other peroxisomal processes.

NSCI 46: *Characterizing the Molecular Defects Associated with Arabidopsis thaliana LON2 Mutations*

Stefanie King

Mentor: Dr. Bonnie Bartel

Abstract: Peroxisomes house several metabolic reactions that produce reactive oxygen species that are sequestered to prevent cellular damage. LON2 is a peroxisomal chaperone and protease protein that, through a not yet fully elucidated mechanism, prevents excessive peroxisomal degradation via pexophagy. LON2 contains three domains: the N-terminus, the AAA ATPase domain, and the protease domain, whose functions in the model plant *Arabidopsis thaliana* remain largely uncharacterized. To determine the functional dynamics of the domains, I am comparing a series of *lon2* lines containing various missense mutations or a truncation in the N-terminus. I present progress toward characterizing these mutants using analysis of protein levels and molecular defects. Preliminary data show protein levels of LON2 and other key peroxisomal proteins, including green fluorescent protein localized to peroxisomes, are altered in the mutant lines. Together these data support the hypothesis that LON2 mediates pexophagy. Further analysis is needed to determine if this mediation is dependent on LON2 levels or the function of particular LON2 domains.

NSCI 47: *Modeling Human p53 Mutations in Xenopus laevis*

Amisheila Kinua

Mentor: Dr. Rachel Miller

Abstract: Li-Fraumeni syndrome, caused by mutations in the tumor suppressor gene, *p53*, results in predisposition to cancer. Tumor protein 53, also known as p53, acts as a tumor suppressor and responds to cellular stressors such as DNA damage. Though p53 is well known for its role as a tumor suppressor, it is also important for normal processes during embryogenesis, including kidney development. Preliminary clinical data indicate that *p53* mutations identified in Li-Fraumeni patients are associated with an increased prevalence of urogenital anomalies, suggesting that p53 may be important for kidney development. Given that nephron structure and function are highly conserved among vertebrates,

Xenopus laevis (frog) embryos will be used to model Li-Fraumeni patient mutations associated with urogenital anomalies. Using morpholino and CRISPR/Cas9 strategies, we show that reduced p53 results in reduced expression of kidney markers. We express patient-identified dominant-negative mutations in the *Xenopus laevis* kidney and find that patient mutations result in a moderate reduction of kidney phenotypes that pheno-copy overexpression of wild-type human p53 above the sub-phenotypic dose.

NSCI 48: *Developing Genetic Tools to Establish Biomphalaria glabrata as a Model Organism*

Davoneshia "Missy" Lollis

Mentor: Dr. Daniel Wagner

Abstract: Model organisms are essential to the field of biology as they serve as representatives of large groups of organisms. While the mollusca phylum consists of a large, diverse group of organisms, a mollusc model combining the features of modern molecular genetics does not exist. We have targeted the freshwater snail, *Biomphalaria glabrata*, as a possible candidate mollusc model. Establishing B. glabrata as a model organism requires tools that allow for detecting and manipulating gene expression. Thus, my work has focused on the optimization of a whole-mount in situ hybridization (WISH) protocol for B. glabrata embryos. The protocol will detect spatial patterns of mRNA expression in embryos. I have successfully transcribed in situ probes that should show strong localized genetic expression and created a protocol that treats embryos with the conditions typical for WISH while conserving embryo anatomy. I have also identified additional genes that are likely to show strong restricted patterns of expression. Future work will focus on refinement of the protocol. Once this protocol is optimized, we will examine the expression of the B. glabrata orthologs of developmental regulatory genes.

NSCI 49: *Investigating EC359 LIF antagonist as a novel treatment option for head and neck squamous cell carcinoma*

Abrar Mamun

Mentor: Dr. Mohan Natarajan

Abstract: Currently, even the most aggressive and site-specific multimodal therapy for treating head and neck squamous cell carcinoma (HNSCC) is ineffective. Diagnosis at an advanced stage, complexity of the head and neck region, a high recurrence rate, and aggressive metastasis account for this clinical

failure. One of the mechanisms by which HNSCC maintains its resiliency is through interactions with leukemia inhibitory factor (LIF) and its receptor, LIFR. This study was aimed at evaluating the effects of EC359, a first in-class LIF antagonist, as a novel treatment option for HNSCC. We assessed the antiproliferative capacity of the drug through in vitro and in vivo models, and then tested for its radiosensitization potential. EC359 significantly inhibited the survival of HNSCC cells in a dose-dependent manner and was found to induce apoptosis, as evidenced by immunoblotting analyses. Additionally, EC359 reduced tumor burden in orthotopic HNSCC mice models and exerted a radiosensitizing effect. Collectively, the data showed that EC359 can serve as a potential candidate for treating HNSCC as a chemotherapeutic drug, as well as a combined modality in combination with radiotherapy.

NSCI 50: *PU.1 Mediated Transcriptional Regulation of Metabolism and Inflammatory Response*

Aditya More

Mentor: Dr. Qiang Tong

Abstract: Research has emphasized the role of oxidative stress-activated signaling—mediated by obesity induced hyperglycemia and elevated free fatty acids—in the onset of diabetes. Reactive oxygen species (ROS) generated by these processes impair insulin signaling and glucose secretion in both animal and human models. PU.1 is an ETS transcription factor involved in development of macrophages, granulocytes, and B lymphocytes. This protein has also been linked to transcriptional regulation of NADPH oxidase, the primary producer of ROS, and transactivation of proinflammatory cytokines in macrophages and adipocytes. Currently, the mechanism behind PU.1-mediated transcriptional regulation—with regards to direct or indirect downstream gene regulation in adipocytes remains unclear. This study uses RNA-seq in conjunction with ChIP-seq to demonstrate that PU.1 mediates both these transcriptional changes by direct binding to the corresponding chromatin regions. Specifically, PU.1 knockout was shown to directly alter the expression of metabolic and oxidative genes involved in insulin signaling and directly suppress genes involved in inflammatory response.

NSCI 51: *Identifying Pharmacologically Inhibitable Regulators of Shank3 Expression*

Alison Oh

Mentor: Dr. Jimmy Holder

Abstract: The *SHANK3* gene encodes for a scaffolding protein in the post-synaptic density of excitatory neurons and its dosage sensitive nature makes it especially susceptible to abnormal neuronal function. *SHANK3* mutation, and subsequent decreased Shank3 protein expression, has been implicated in several neurodevelopmental disorders, such as autism, epilepsy and, Phelan-McDermid syndrome. Through a flow cytometry screen of pharmacologically targetable proteins, our lab has identified several candidate genes that are potentially involved in the regulation of Shank3 protein stability. We further validated these candidate genes through siRNA knockdown, fluorescence activated cell sorting (FACS), and western blotting to confirm their effects on Shank3 protein stability. Significant increases in Shank3 expression were observed with CSNK1α knockdown, and we are currently verifying similar effects with chemical inhibition using D4476. By identifying and verifying upstream regulators of Shank3, we hope to discover potential pathways for personalized therapeutic interventions aiming to normalize protein levels to treat neurodevelopmental disorders associated with SHANK3 haploinsufficiency.

NSCI 52: *First Generalized 21 Amino Acid Translational System through OMeY Biosynthesis*

Yuanzun “Zane” Peng

Mentor: Kuan-Lin Wu

Abstract: Utilization of chemically or biosynthetically modified amino acids has been an expanding field with relevance to a wide range of applications. However, to date, the introduction of unnatural amino acid (UAA) into biological systems has been limited to exogenous feeding of high concentration of UAAs. We introduce O-Methyltyrosine (OMeY) as the first demonstration of a 21st amino acid that can be biosynthesized and incorporated into proteins of both prokaryotic and eukaryotic cells. Phenolic 4-O-methyltransferase mfnG and an orthogonal aminoacyl tRNA synthetase/tRNA pair were introduced into E.coli and mammalian cell line HEK293T to demonstrate the biosynthesis and incorporation of OMeY into GFPs at the TAG amber codon. Fluorescence measurement showed 1.5X higher fluorescence signal E.coli in with biosynthesis than the feeding control and comparable signals in HEK293T. Cells without OmeY feeding or the

mfnG plasmid demonstrated little to no fluorescence. In conclusion, this work demonstrates the first generalized 21 amino acid-translational system that could work in multiple species and the first autonomous eukaryotic cell line that produces proteins with 21 amino acids.

NSCI 53: *Conferring Thermotolerance upon Coral Symbionts through Genetic Transformation*

Nishant Pradhan

Mentor: Dr. Michael Gustin

Abstract: Coral reefs are threatened by rising ocean temperatures, leading to a disruption of the coral-symbiont relationship and coral bleaching. Conferring increased thermotolerance upon these symbionts (Symbiodiniaceae) through the addition of trehalose phosphate synthase genes to the native genome can increase their resilience to higher temperatures and adapt the coral ecosystem to withstand rising ocean temperatures. However, genetic transformations of these symbionts in the past have not been widely successful. This study investigates the process of genetic transformation in both *Cladocopium goreaui* and *Symbiodinium microadriaticum* coral symbionts by designing plasmids to be inserted into the genomes and observing their uptake through newly expressed characteristics of the organisms. The project is currently in the stages of modifying plasmid sequences to achieve maximum compatibility for insertion. Along with plasmid modification, PCR and protoplast generation are used to achieve successful plasmid uptake and genetic transformation of the symbionts. Future directions after achieving transformation include inserting trehalose phosphate synthase genes to confer thermotolerance.

NSCI 54: *Generation of TLR9 Knockout Human Lung Epithelial Cells via CRISPR CAS 9*

Tanner Reese

Mentor: Dr. Scott Evans

Abstract: Our respiratory surfaces are constantly exposed to pathogens and other microorganisms. Lower respiratory tract infections results in more quality-adjusted life years lost due to death or disability than any other condition worldwide. Specifically, chemotherapy patients are extremely susceptible to these pathogens. TLR9 agonists have been shown to protect against pneumonia and other influenza infections in mice. I was tasked with conducting TLR9 knockout in human bronchial cells using CRISPR CAS9 gene-editing strategy to eventually examine its effect on preventing respiratory infection. After troubleshooting,

TLR9 gRNA insertion into px458 Cas9 GFP-plasmid using golden gate cloning process was successful. I have also used Lipofectamine 3000 reagent to transfect TLR9-GFP CRISPR plasmid into human bronchial epithelial cells (hBEC-3kt) to attempt TLR9 gene knockout. After GFP sorting, I identified seven potential TLR9-knockout colonies. Preliminary sequencing data provided evidence of DNA-level changes to three colonies, with three others inconclusive. I am currently testing these colonies using western immunoblotting and in vitro infection assays.

NSCI 55: *Experimental Evolution of Pseudomonas aeruginosa for Verification of Microfluidic Biomarker Discovery Platform Efficacy*

Cailey Renken

Mentor:

Abstract: Discovering biomarkers associated with resistance is instrumental in drug development and understanding the biochemistry behind antibiotic resistance. Our lab has developed a microfluidics-based technology (Microfluidic Biomarker Discovery Platform or MBDP) that is automated and able to rapidly provide lists of significant identified biomarkers. In order to assess the validity of the MBDP, previously established experimental evolution techniques were used to evolve *P. aeruginosa* PAO1. Hypermutation has been specifically observed in *P. aeruginosa* evolving to colistin, a cationic antimicrobial peptide (CAP) drug of last resort, in a bioreactor as a continuous culture. In this work, serial flask transfers were performed to evolve PAO1 to 16 µg/mL colistin resistance following which, evolution was conducted using MBDP. Evolved strains from the two different evolution platforms will be whole genome sequenced to identify mutations conferring resistance. Finally, results from the three different types of evolution experiments will be compared to determine the efficacy of using MBDP as a high-throughput method for discovery of antimicrobial resistance-associated biomarkers.

NSCI 56: *IsoformSwitch: A resource and analytic tool for cancer research*

Alicia Selvera

Mentor: Dr. Sendurai Mani

Abstract: Relative expression of genetic isoforms influences development, homeostasis, pluripotency, apoptosis, as well as many other biological processes and is thought to play an important role in cancer progression. In order to

characterize the relative levels of gene transcripts, we developed IsoSwitch. IsoSwitch processes RNAseq data and provides simple and easily digestible information about the variance in isoform expression across cancer type and stage. IsoSwitch currently exists as a series of R functions that can be grouped together to form an R package. In the future, we hope to implement IsoSwitch as an interactive web tool to be used by physicians and researchers.

NSCI 57: *Cell-Specific Neuromodulation of Bioengineered All-Inducible Human Synaptic Networks*

Arya Shetty

Mentor: Dr. Robert Krencik

Abstract: Neural sphere cultures derived from human pluripotent stem cells are increasingly utilized as models for human neural networks, yet these systems lack efficient production and the means for cell-specific activity modulation. We demonstrate an innovative framework to rapidly produce all-inducible neuron and astrocyte coculture spheres containing genetically encoded capabilities for optogenetic and chemogenetic activation. Expansion of this approach can yield increasingly relevant models for disease research and drug discovery.

NSCI 58: *Characterization of the Effects of STK521720 on Net1-dependent Actin Cytoskeletal Reorganization*

Tracy Tse

Mentor: Dr. Jeffrey Frost

Abstract: Increased cell motility and loss of cell anchorage are two hallmarks of metastatic cancer cells that inherently require actin cytoskeletal reorganization. Rho GTPases are important regulators of actin cytoskeletal organization, and these proteins are activated by upstream guanine nucleotide exchange factors (GEFs). Net1 is a RhoGEF that is overexpressed in metastatic breast cancer cells and activates the Rho GTPase family protein RhoA. Interaction of RhoA with constitutively active Net1 leads to increased F-actin accumulation and cytoskeletal reorganization. Therefore, it would be useful to find an inhibitor for Net1 to block its ability to activate RhoA. Doing so will move us towards a potential treatment for metastatic breast cancer. Previous data suggests that 2-(4-Hydroxystyryl)quinolin-8-ol (STK521720 or STK) is a promising candidate

drug for inhibiting Net1 catalytic activity. This study will identify the ideal concentration of STK for reducing F-actin accumulation in NIH3T3 fibroblast cells transfected with constitutively active Net1. We will also show that STK is specific for Net1, and does not affect the function of RhoA itself, or that of another RhoGEF, Dbl.

NSCI 59: *Investigating the Role of HB-EGF in the IRE1α -XBP1 Pathway in Tumor Development*

Stanley Tsou

Mentor: Dr. Xianzhou Song

Abstract: The accumulation of unfolded or misfolded proteins in the endoplasmic reticulum (ER) can lead to ER stress and activate the unfolded protein response (UPR), a complex signal transduction pathway that is initiated by three UPR stress sensors: inositol-requiring enzyme 1α (IRE1α), protein kinase RNA-like ER kinase (PERK), and activating transcription factor 6 (ATF6). As the most evolutionarily conserved of the three pathways, the IRE1α-XBP1 pathway plays a critical role in tumor growth and metastasis. However, molecular signals regulating the IRE1α-XBP1 pathway are largely unknown. Using a whole genome-wide siRNA screen, our lab has previously identified 165 genes that modulate XBP1 activation. Here, in particular, we demonstrated that soluble heparin binding EGF-like growth factor (HB-EGF) can induce XBP1s expression in pancreatic cancer cells through the mTOR pathway. These findings represent a novel form of the unfolded protein response and an important regulatory mechanism for modulating IRE1α-XBP1 signaling.

NSCI 60: *Native-Condition Structural Characterization of the Nematode Virus Orsay and Associated Host Proteins*

Jim Zhang

Mentor: Dr. Jane Tao

Abstract: Orsay is the first known natural virus capable of infecting *C. elegans*, a valuable laboratory model. The non-enveloped virus presents a promising opportunity to develop a host-pathogen system capable of modeling eukaryotic viral infection. Orsay's (+)-ssRNA genome encodes for a capsid protein (CP), an associated protein *δ*, and an RNA-dependent viral polymerase. *δ*, which has been

demonstrated to facilitate viral entry and nonlytic egress, can be expressed either as a free or fusion (CP-*δ*) protein. Prior research efforts have successfully structured Orsay CP and truncated-*δ* proteins individually through crystallography. However, a composite structure of the CP-*δ* fusion protein and native Orsay virion remains unsolved.

Here, we report an iodixanol-based purification protocol capable of isolating Orsay virions containing CP-*δ*. When this protocol was applied to a concentrated solution of supernatant derived from Orsay-infected *C. elegans*, fractions of pure and concentrated CP-*δ* were isolated from surrounding host proteins. The resulting samples of CP-*δ* served as viable candidates for high resolution data collection and structuring through cryogenic electron microscopy.

Other Works in Natural Sciences

NSCI 61: *The SNARE Regulator Complexin 3 is a Target of the Cone Circadian Clock*

Jacob Bhoi

Mentor: Dr. Christophe Ribelayga

Abstract: BMAL1 is a core component of the mammalian circadian clockwork, and its removal significantly affects visual information processing in both rod and cone pathways. We performed an RNA-seq differential expression analysis between cone-specific *Bmal1* knock out (cone-*Bmal1*-/-) cones and WT cones. Among the 88 genes identified, *Complexin3* (*Cplx3*), a SNARE regulator at ribbon synapses, was downregulated fivefold in the mutant cones. The purpose of this work was to determine whether BMAL1 or the clock controls CPLX3 protein expression in cones. We found that CPLX3 expression level was decreased in cone-*Bmal1*-/- cones. Furthermore, CPLX3 was downregulated at night in WT cones but remained constitutively low in mutant cones. The transcript and protein expression levels of *Cplx4*, the other complexin expressed in cones, were similar in WT and mutant cones and did not change with time of day. Our results suggest that CPLX3 is regulated at the transcriptional level by the cone clock. The modulation of CPLX3 may be a mechanism by which the clock controls cone synaptic transfer to second-order cells, thereby impacting retinal signal processing during the day/night cycle.

NSCI 62: *Characterizing Gene Regulation in Streptomyces*

Katherine Cohen

Mentor: Dr. James Chappell

Abstract: Streptomyces is a genus of bacteria with extensive secondary metabolite production. However, Streptomyces is poorly characterized and only has a limited toolset for synthetic regulation of gene expression. In order to exploit these bacteria for biotechnology and drug discovery, we have created three classes of synthetic gene regulators for Streptomyces venezuelae. First, various promoters were tested in Streptomyces using mCherry fluorescence as a reporter. Subsequently, these characterized promoters were used to optimize a Clustered Regularly Interspaced Short Palindromic Repeats interference (CRISPRi) system in Streptomyces. CRISPRi provides specific transcriptional repression. The third genetic regulation tool characterized were anti-sense RNAs (asRNAs). AsRNAs are post-transcriptional regulators which block translation by binding to Ribosome Binding Sites (RBS). A simple linear asRNA followed by a terminator hairpin, a modified natural five-hairpin asRNA, and an HFQ protein associated with a guide RNA were tested for mCherry repression. In summary, we have created novel gene regulatory tools that will enhance our ability to engineer and exploit Streptomyces for biotechnology.

NSCI 63: *Characterizing the Natural Enemy Communities Associated with Two Hosts Across Two Environments*

Charles Davis

Mentor: Dr. Scott Egan

Abstract: How are species-rich natural enemy communities structured across hosts and environments? We address this question using two cynipid gall wasps across two host plant environments. Cynipids are specialist wasps whose oviposition in new tissues prompt their host plants to create tumor-like growths called galls. While galls provide the cynipid larva with some protection, the larva is targeted by many antagonistic arthropods termed natural enemies. Much of the natural enemies in these systems and their interactions with the gall wasp are underdescribed and warrant further study. Eight gall wasp species cooccur on the live oak species, Quercus virginiana and Q. geminata, which are sympatric across the southeastern United States, but it is unclear how these natural enemy communities overlap. Therefore, characterizing the natural enemies for each

species will provide insight into the complex food webs associated with these wasps. Here we describe the natural enemies of the gall wasps Andricus quercusfoliatus and Callirhytis quercusbatatoides using morphology and genetic sequencing. Across 2497 insects reared across both galls, 8 out of the 64 identified morphospecies are potentially shared

NSCI 64: *Determining the Presence and Cause of Tool Use Specialization in Ant Colonies (Aphaenogaster treatae)*

Alice Gong

Mentor: Dr. Scott Solomon

Abstract: Unlike most ant species, ants in the genus *Aphaenogaster* are unable to carry large amounts of liquid food in their body. This prevents foragers from feeding other colony members via regurgitation. This issue is solved through tool use. Seven species in the genus are able to drop debris into liquid food and carry the soaked debris back to the colony. In two species, a small group of workers specialize in tool use while the presence of specialization remains unknown for other species. This study aims to determine the presence, type, and cause of specialization in *Aphaenogaster treatae*. Ants observed to drop tools were isolated. Their tool use speed and capability were compared with that of randomly captured workers. After tool user isolation, changes to the colony foraging were observed. The results confirmed specialization. While many individuals were capable of tool use, some were genetically predisposed to be better users. Thus, only a small group typically carried out the task. The study provides insight to specialization in *Aphagenogaster* tool use, which has not been closely studied. Results could also provide insight to tool use in social insects and other animals.

NSCI 65: *Relationship Between Social Networks and Vigilance Behavior in Captive Slender-Tailed Meerkats, Suricata suricatta*

Jordan Graves

Mentor: Dr. Amy Dunham

Abstract: Vigilant behaviors allow animals to keep watch but cost time that could be spent foraging or maintaining social interactions. To combat this, certain group-living species share vigilance duties to minimize costs, but roles are not always split evenly. Previous studies show vigilance can correlate with affiliative and aggressive social hierarchies, but vary between species in the direction of correlation. Slender-tailed meerkats, *Suricata suricatta*, use sentries for vigilance that stand guard and alarm call for the mob and also have complex social lives,

yet the relationship between vigilance and mob social networks remains largely unknown. I hypothesized that because conspecifics pose little threat, subordinate meerkats spend more time vigilant to watch for predators so that dominant individuals can forage and take care of young. Two captive meerkat mobs were observed for vigilance and social interactions using continuous and scan sampling. Dominance and allogrooming networks were created for each mob and compared to individual vigilance proportions. Preliminary results confirm this hypothesis suggesting dominants gain vigilance benefits without the cost.

NSCI 66: *Machine Learning to Automate Manual Review of Somatic Variants in Hematological Malignancies*

Yi June Kim

Mentor: Dr. Koichi Takahashi

Abstract: Genomic analysis of cancer has allowed numerous merits to patients such as design of individualized treatment and better prognosis of metastasis. However, translation of raw sequenced data into meaningful information still presents many challenges. One of the bottlenecks persists in the manual review of somatic variants, where a trained pathologist must examine hundreds of features and rely on his or her knowledge to manually classify whether each sequenced variant appears somatic or not. This has raised issues in time, cost, and objectivity of classification. Only in the past one year, newest researches have been published in the attempts to automate such process using machine learning techniques. My research is distinguished from those in that it is specifically focused on liquid tumor types (hematological malignancies), and therefore, it did not use matched normal to build the model. In addition, the model was built on sequenced dataset of gene panel, as opposed to that of whole exome, proving itself more efficient and cost-effective than the latter.

NSCI 67: *Characterizing the Natural Enemy Community of the Gall Midge Arnoldiola atra (Diptera: Cecidomyiidae) in Florida*

Briley Mullin

Mentor: Dr. Scott Egan

Abstract: Gall-forming insects are a diverse group of parasites that induce plant tissue to develop a variety of gall structures, whose function is to encapsulate and nourish developing larvae. These galls are then attacked by a vast community of natural enemies that exploit the living space of their hosts. The life cycles of these natural enemies depend on the phenology of their gall-forming hosts, and

gall-formers likewise experience phenological selection pressure from their natural enemies. Quercus virginiana (Qv) and Q. geminata (Qg) are sister species of live oak that share the parasitic gall midge Arnoldiola atra (Diptera: Cecidomyiidae). Here I aim to characterize the natural enemy community of A. atra and the differences in emergence date of each of these species across both oak hosts. I examined insects reared from galls collected from Qg and Qv trees throughout Florida and identified distinct morphospecies present in the collection. Between five and seven hymenopteran parasitoid species attack A. atra across both Qg and Qv, but their phenological relationships with A. atra vary. Additionally, only two morphospecies show significant differences in emergence date between Qg and Qv.

NSCI 68: *Awake Mouse MRI*

Ivany Patel

Mentor: Dr. Robia Pautler

Abstract: Anesthesia such as ketamine and isoflurane are often used in preclinical studies that incorporate mouse models. However, multiple reports indicate that anesthesia has a significant impact on the physiology of any system. For example, anesthesia is a confounding factor in animal brain functional MRI studies due to the interference of anesthesia. The most commonly used anesthetic gas, isoflurane induces relaxation of blood vessels by acting on and interfering with calcium signaling by blocking calcium channels in vascular smooth muscle. Thus, there is great interest in performing studies in awake, unanesthetized animals. In this project, we have significantly modified the rat holder described in Stenroos et al to accommodate mice, specifically in Bruker systems and have also established a successful conditioning paradigm. We have obtained anatomical images as well as compared 31P spectra and also Manganese Enhanced MRI (MEMRI) transport rates in awake animals. Our data demonstrate significant differences in 31P spectra and MEMRI transport rates in anesthetized vs awake animals and emphasize the importance of pursuing functional studies in unanesthetized animals.

NSCI 69: *Divergence of Reproductive Strategy Between Host-Associated Populations of a Gall-Forming Insect*

Amy Roush

Mentor: Dr. Scott Egan

Abstract: Trait divergence between populations can occur during the process of local adaptation to different environments and reproductive isolation between populations. Studies have shown divergence in morphological traits due to divergent selection, but whether reproductive strategies differ is unclear. Aspects of reproductive strategy such as fecundity and egg size are important life history traits that affect individual fitness. This study explores divergence in reproductive strategy in a gall-forming wasp, *Belonocnema treatae*, which feeds on host plants *Quercus geminata* and *Q. virginiana* and exhibits divergence in phenology, morphology and behavior. Number of eggs and egg size were measured for a total of 182 individual females from eight populations, three on *Q. geminata* and five on *Q. virginiana*. We then compared whether these reproductive traits differed between hosts with and without controlling body size (estimated via tibia length). We found that egg number relative to body size was greater for wasps adapted to *Q. geminata* than wasps adapted to *Q. virginiana*, which suggests divergence in reproductive strategy.

NSCI 70: *Synthesis of Enantiopure Orthogonally Protected 2-Substituted Piperazines as Versatile Synthetic Building Blocks*

Manuj Shah

Mentor: Dr. Damian Young

Abstract: In recent time, fragment-based drug discovery (FBDD) has quickly emerged as a widely recognized principle to discover lead compounds and chemical probes. The piperazine-based platform has been extensively used in many FDA approved drugs and many biologically important compounds, but its chemical diversity has been limited to nitrogen diversifications. We look to introduce substitutions on the sp3-hybridized carbons and explore their powerful stereochemistry potential. Starting from various commercially available amino acids, a diverse array of monosubstituted piperazine scaffolds has been constructed efficiently in a three-step process. The key transformation involves an aza-Michael addition between an orthogonally bis-protected chiral diamine and the *in situ* generated vinyl diphenyl sulfonium salt derived from 2-bromoethyl-diphenylsulfonium triflate. Further validated with various

protecting groups and on multigram scale, this method can be applied to construct chiral 1,4-diazepane and 1,4-diazocanes as well.

NSCI 71: *Analyzing Data Collected During the Process Evaluation of Year 1 of Fit 5 Kids*

Anu Singh

Mentor: Dr. Teresia O'Connor

Abstract: Fit 5 Kids is a culturally adapted screen time reduction curriculum for Latino preschoolers in Head Start centers. It is a cluster randomized controlled trial (RCT) and seeks to teach preschoolers how to decrease their screen time by encouraging alternative behaviors. The objective of this study is to determine the extent to which the Fit 5 Kids program is being successfully delivered in the Houston center. Process evaluations of the curriculum delivery are being conducted to ensure proper fidelity across the three sites and four intervention years. The delivery of the curriculum was evaluated by a standardized checklist to assess fidelity by identifying the curriculum components delivered during each lesson of the 7-week curriculum. The checklist components will be defined as outcome measures and qualitatively scored against the published curriculum guidelines, generating a cumulative score for each lesson and a mean score for each outcome measure. Comparison of these scores will help determine the success of the lessons, assess the fidelity of program implementation, and generate potential solutions for future implementations.

NSCI 72: *Creating Streptomyces Reporter Strains to Study Social Interaction of Bacteria*

Jessica Weng

Mentor: Dr. Yousif Shamoo

Abstract: Bacteria are always working together or competing with other bacteria and will inhibit the growth of other bacteria with molecules that have been isolated as antibiotics. The genus *Streptomyces* has produced over 80% of current antibiotics. As antibiotic resistance has become a pressing international health issue, chemically modifying current antibiotics to create new antibiotics is slow and the pathogen may quickly overcome the modifications. There is a need to discover new molecules to combat how quickly pathogens become antibiotic resistant. Literature shows that there are cryptic pathways in the genome that could produce secondary metabolites with potential as antimicrobials. These cryptic pathways and secondary metabolites may be activated and produced when the bacteria interact with other species of bacteria in beneficial or negative ways.

The aim of this project is to co-culture *Streptomyces* in droplets so that the strains can interact with each other and potentially activate the cryptic pathways. The *Streptomyces* fluorescent reporter strains facilitate the characterization of interactions in droplets and downstream fluorescence-based sorting processes.

SOCIAL SCIENCES

Cultural Ethnic and Gender Studies

SOSC 73: *Student Biases Against International Professors: How Does Rice Compare?*

Sophie Clayton, Richelle Huang, Molly Lu, Lauren Palladino

Mentor: Dr. Sandra Parsons

Abstract: Student evaluations of professors at the university level are often used to determine job placement, promotions, and research opportunities. However, understanding the implicit biases of students presents a difficulty to researchers. This project aims to explore the biases present in the undergraduate student body at Rice University. We predicted the presence of the main effects of both the place of birth and the place of education of professors. In a survey of 104 Rice students, we presented descriptions of professors with manipulated information on their places of birth and locations of education. After the vignettes, students were asked about their interest in their courses and whether they believed each of the professors had the credentials to teach. Our results indicate a simple main effect of the place of education. There was no effect of place of birth, nor an interaction between the two. The findings of this study shed light on the biases held by students on campus at Rice University.

Human and Medical Lifesciences

SOSC 74: *Telehealth as a scalable method to increase health promoting behaviors using Reversal Theory in cancer survivors*

Frank Frankovsky III

Mentor: Dr. John Mulligan

Abstract: Telehealth has been employed to increase post-operative compliance and health-promoting behaviors in a cost-effective, home based manner. The increased positive metrics seen stem from a change in the self-efficacy and motivational state of the individual brought on through the telehealth intervention. The use of different Cognitive Behavioral Theories, such as Social-Cognitive

Theory and Reversal Theory, are coupled with these interventions to provide consistent reinforcement towards analyzing and supporting the motivational state of the participants. Telehealth offers a low-cost approach to holistic health interventions that can be completed and useful within the home, limiting demographic constraints on the participants.

Cancer survivors are often overlooked for holistic interventions such as telehealth, as the primary metric concerned in a clinical study for the population are 5-year survival rates. In this presentation, an alternative is proposed where telehealth intervention serves as a media for not only increased compliance with treatment plans, but an increase in health-promoting behaviors and a maximized quality of life.

Social Behavioral and Economic Studies Qualitative

SOSC 75: *Priming and Privilege: The Effect of Priming on Awareness of Racial Privilege*

Beth Buchanan, Lily Cao, Chelsey Wen, Lindsay Josephs

Mentor: Dr. Sandra Parsons

Abstract: Research has shown that white students have lower racial privilege awareness than students of color (Worthington et al., 2008). Evaluating racial privilege awareness is important to explore how Rice can improve its understanding of race issues. We manipulated profiles of students to explore how race (White; Black) and socioeconomic status (High-Income; Low-Income) priming affect racial privilege awareness. We hypothesized that participants would report greater racial privilege awareness scores when primed with stereotypical profiles (Black Low-Income; White High-Income). We distributed a survey to 102 Rice students with 1 of the 4 scenarios, the racial privilege awareness scale, and demographic questions. There was no significant difference in racial privilege awareness based on the scenario the participants saw, p > .05. An analysis of participant SES suggests that low-income students' awareness of racial privilege scores varied more across scenarios than did those of mid-income and high-income students. However, none of these differences was significant, p > .05. These results showed that future studies should explore the relationship between SES privilege and racial privilege.

SOSC 76: *The Effects of Gender on Perceptions of Social Anxiety*

Chris Cone, Amanda Spitzer, Nyla Vela, Russell Ku

Mentor: Dr. Sandra Parsons

Abstract: Perceptions of social anxiety on college campuses is an extremely pertinent issue. Furthermore, the effect of gender on that perception is valuable for analyzing any trends or differences. The larger work surrounding this topic could be applied beyond the college campus and considered in terms of the general public.

Treatment of those with socially anxious behaviors could be adjusted according to how they are perceived. This study will be performed using a campus-wide administered survey. Within the survey the subject will read one of four different vignettes depicting a man or woman either socially anxious or not. And then fill out questions about whichever vignette they received. The results from this survey will then be analyzed using a 2x2 ANOVA test.We believe that perceptions of individuals that depict more socially anxious behaviors will be more negative. We expect results indicating that men who are perceived as socially anxious will be reported as the least favorable of the four different vignettes.This work can be used to more appropriately understand the implications of social anxiety on men and women.

SOSC 77: *The Measurement of Trust in Self-Driving Vehicles Using a Low-Cost Virtual Reality Headset*

Katie Garcia

Mentor: Dr. Philip Kortum

Abstract: This presentation will report the results of a study that compared presentation methods for use in the validation of the Trust in Self-driving Vehicle Scale (TSVS), a questionnaire designed to assess user trust in self-driving cars. Previous studies have validated trust instruments using traditional videos wherein participants watch a scenario involving an automated system, but there are strong concerns about external validity with this approach. In this study, there were four presentation conditions: a flat screen monitor with a traditional video, a flat screen monitor with a 2D 180 video, an Oculus Go VR headset with a 2D 180 video and an Oculus Go with a 3D VR video. Participants watched eight video scenarios. Participants rated their trust in the vehicle shown in the video after each scenario using the TSVS and rated telepresence for the viewing condition. We hypothesize that there will be no statistically significant differences in the mean trust ratings

between the four different presentation conditions. We also predict that there will be a statistically significant higher mean ratings on telepresence for the headset conditions than the two 2D video conditions.

SOSC 78: *Development Finance Policy for Universal Electricity Access*

Trisha Gupta, Lisa Lin

Mentor: Dr. James DeNicco

Abstract: This paper examines global energy access and offers proposals to improve electrification globally. Through utilizing the developmental finance tools of the newly formed United States International Development Finance Corporation (USIDFC), this paper addresses financing global energy infrastructure. The current iteration of the USIDFC, constructed as an improvement upon the Overseas Private Investment Corporation (OPIC), fails to optimize its potential in energy financing by restricting eligible business partners, providing inefficient approaches to supporting independent economies, and failing to include comprehensive oversight. In order to rectify these issues, this paper proposes these policy alterations: elimination of US-affiliation preference, reevaluation of equity finance benefits, abolition of small business requirement, further involvement of local business, and confirmation of transparency. The USIDFC, through implementing these policies, will promote global energy access in an efficient manner while avoiding the issues of the OPIC. In conclusion, this paper offers improvements to the USIDFC to promote greater energy infrastructure and energy access across the globe.

SOSC 79: *Transience among homeless bodies and mobile technologies in a feminist new materialist lens*

Jolen Martinez

Mentor: Dr. James Faubion

Abstract: Homelessness is often associated with certain technologies found in inconspicuous areas of the urban landscape. These materials, such as the cart and tent, are frequently entangled with the marginalized persons that live within them or through them, interacting with and forming different experiences of transience. This paper utilizes a feminist new materialist, decolonial, and science and technology (STS) approach to understand the various encounters homeless persons make with these technologies and how new assemblages give rise to new subjectivities as things resist or facilitate “transience”. The ethnographic data for

this paper comes from three years of fieldwork involving participant observation and interviews along the Houston homeless service-corridor (adjacent to Highway Interstate-69). I ask: how do the material-infrastructures surrounding the urban landscape that homeless persons experience afford certain mobilities for them, what are the political ecologies of these materials, and how do their intra-actions create new homeless subjects that are disciplined as "transient"? This paper offers an alternative to the pathologization of homeless populations in Houston.

SOSC 80: *Public Libraries as Social Infrastructure in Disaster Resilience and Recovery: Houston Libraries and Hurricane Harvey*

Allison Yelvington

Mentor: Dr. Jim Elliott

Abstract: Current work in the social sciences highlights social infrastructure and its role in communities, especially in cases of disaster resilience and recovery. This study furthers that body of work by examining the role of public libraries in flooding recovery and resilience through the case of Hurricane Harvey in Houston, Texas. By combining spatial analysis with in-depth interviews with library staff, this study finds that public libraries are well situated to serve vulnerable communities not only during immediate emergency response but also in long-term recovery and resilience planning. Libraries in Houston are located in close proximity to those who experienced flood damage as well as to those who are socially vulnerable. During disaster recovery public libraries provide a place to build social capital, navigate recovery resources, and re-establish normalcy. Interview results also indicate that library staff themselves are a vital part of the social infrastructure. However, there are limitations on staff including compassion fatigue, lack of specific training, and lack of funding. These results encourage further study of social infrastructure and offer policy implications.

Social Behavioral and Economics Sciences Quantitative

SOSC 81: *Examining the feasibility of an ecological momentary assessment paradigm to assess stress and health among older adults*

Ashley Fite

Mentor: Dr. Christopher Fagundes

Abstract: Everyday stressful life experiences impact the health behavior decisions and health outcomes of older adults. Novel methods, such as those that fall under the ecological momentary assessment framework, can illuminate the daily experiences of these relationships. We assessed the feasibility of employing a mobile phone-based EMA paradigm to examine the relationship between stress and health among adults aged 55+. Participants were recruited from the control subject pool of Project Heart, an R01-NIH funded study run through the Rice BMED lab, and asked to complete a take home survey series on their mobile phones for four days. We aim to determine the feasibility and acceptability of a technology-based EMA study among a community-based sample of older adults through measures of protocol compliance, survey completion rates, and qualitative responses of EMA acceptability. We plan to run descriptive statistics and limited-efficacy testing of our independent and dependent variables. A technology-based EMA framework to examine these relationships in older adults could inform future life-enhancing and life-saving health interventions.

SOSC 82: *Effect of Feedback on Group Performance on Attention Task*

Najah Hussain, Danielle Kessler, Jacob Liang, Elise Tan

Mentor: Dr. Sandra Parsons

Abstract: Residential college can be an important aspect of identity for Rice University undergraduates, so we believe that students may experience stereotype threat based on their college. We predict that students that receive negative feedback about their college's average performance will perform worse on a second round of Stroop tests, and this may be moderated by the student's self-reported involvement in their residential college. Participants completed an online questionnaire asking about residential college involvement, then took a Stroop test and self-reported their response times. After receiving either positive or negative feedback about their college's average performance on the Stroop test, they completed a second Stroop test and self-reported their response times. We did not find any statistically significant changes in the change in Stroop response

times for either the positive or negative feedback conditions. We also did not find any significant main effect of residential college involvement on change in Stroop response time; there was no significant interaction between college involvement and feedback condition.

SOSC 83: *Linguistic Mechanisms of the Relationship Between Perceived Burdensomeness and Negative Health Outcomes*

Jade Kanemitsu

Mentor: Dr. Angie LeRoy

Abstract: Perceived burdensomeness (PB; feeling like a burden to others) is linked to a host of negative health outcomes. An individual's variation in word usage reflects their mental state. Studying linguistic differences in the context of being burdensome to others can shed light on possible mechanisms explaining the PB-poor health link. This study used LIWC (Linguistic Inquiry and Word Count) to investigate linguistic variation among 268 participants who wrote about an experience when they were burdensome to a group (burdensome condition) or contributed equally to a group (control condition). We are currently conducting exploratory analyses, which will be complete by the time of the conference. Preliminary analyses revealed that participants in the burdensome condition reported significantly greater depressive symptoms than those in the control condition (b=4.70, p<.001). A simple mediation analysis revealed the number of anxious words participants used (e.g., "worried," "fearful") significantly mediated condition (dummy coded 1=burdensome, 0=control) and depressive symptoms (95% CI= [.06, 1.54]). These results may increase our understanding of why PB is related to poor health outcomes.

SOSC 84: *Analysis of Differences in Working Memory and Narrative Production at 1month Post-Stroke Compared to Acute Stage*

Riya Mehta

Mentor: Dr. Randi Martin

Abstract: Previous research suggests that some deficits in speech production in people with aphasia are mediated by their working memory (WM) abilities. The role of WM in language production depends on the type of WM involved. Previous case studies in chronic aphasia have shown a role for semantic WM in determining the degree of elaboration of the content of utterances and suggest no role for phonological WM, due to a proposed smaller extent of phonological

planning. However, recent evidence from acute stroke suggests a role for phonological WM in speech rate. This study assesses improvements in performance for the same individuals on measures of WM, narrative production (storytelling), and single word production from 72 hours post-stroke to 1-month post-stroke. Results will provide insight as to the areas of improvement and the types of errors made from the acute to the 1-month post-stroke stage. Most critically, it will evaluate whether improvements in different aspects of WM lead to differential changes in narrative language ability.

SOSC 85: *Emotion Regulation and Connectedness Health Outcomes (ECHO)*

Jeniffer Truitt

Mentor: Dr. Bryan Denny

Abstract: Social connectedness is often correlated with positive mental health indicators, serving as a defense against isolation and stress. Similarly, adaptive emotion regulation has been associated with better physical and mental health. Even so, social connectedness and emotion regulation have rarely been examined in relation to each other. This study aims to examine the relationship between these two constructs and whether they are associated with depressive or anxiety-related symptoms, as well as overall health indicators. The study will use a cross-sectional design with a subject pool of undergraduates over the age of 18 at Rice University. Results currently pending.