THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

Undergraduate Research Opportunities Consortium

Abstract Review

Summer 2016

UROC

Undergraduate Research Opportunities Consortium

21st Annual Undergraduate Research Opportunities Consortium Conference

- Summer Research Institute
- Minority Health Disparities (MHD)
- Maximizing Access to Research Careers (MARC)
- Student Affairs Research Program (STAR)
- UROC - PREP
- Biosphere 2 - Research Experience for Undergraduates
- CAT Vehicle / Electrical and Computer Engineering
- Research Experience for Undergraduates
- Research in Optics (RIO)

Summer Research Institute (SRI)

Executive Director: Andrew Carnie, PhD Program Director: Donna Treloar, MA

Faculty: Andrew Huerta, PhD

Summer Research Institute, funded by the University of Arizona, is open to juniors and seniors of all disciplines, including social science, humanities, fine arts, and STEM. SRI accepts students from other universities as funding is available.

Guadalupe Bermejo

Hunter College

New York, New York

mentor: Jake Jacobs

Rule Governance: Fidelity Within Generations of People

Rule governance is defined as behavior that is influenced by rules (Hayes, 1993). This pilot study examined if adhering and putting rules into practice supports high fidelity within generations of people. Rules that do not contain fidelity will change, hence becoming an unreliable source for the next generation of people to use. Memes are defined as an element of culture that is passed from generation to generation (Dawkins, 1976). Memes and rules are different, but if participants adhered to the rules, then it can share the similar high fidelity as memes. The pilot study consisted of 16 participants from The University of Arizona that were divided into four generations of people who were randomly assigned to two conditions: the distractor task, in this case, a PowerPoint about The University of Arizona, and the experimental condition, the Computer-Generated Arena (C-G Arena). Afterwards, participants in both groups recreated the instructions on how to locate an invisible target in the C-G Arena for the next generation. Data analysis will examine the output file of the C-G Arena by measuring the path length, amount of time spent on each quadrant in the C-G Arena, and latency of finding the invisible target. Additionally, we will examine the recreated instructions by each generation of people to determine if fidelity is consistent across generations. Further research with a larger population is needed to enlarge the sample size in order to make a generalization about rule governance.

Jayme Biakeddy

Northern Arizona University

Flagstaff, Arizona

mentor: Jesse Martinez

Obstructive Sleep Apnea and High-fat Diet lead to Inflam mation of the Liver

Primary liver cancer is the third leading cause of cancer mortality worldwide. Eighty-five percent of liver cancers are comprised of hepatocellular carcinoma (HCC). Additionally, obesity is generally regarded as a prime risk factor for the development of obstructive sleep apnea (OSA), a repeated obstruction of the upper airway during sleep leading to oxygen deficiency (OD), which also increases the incidence of non-alcoholic steatohepatitis (NASH). The presence of NASH has also been associated with an increased risk of developing HCC, therefore we predict that patients who have both comorbidities may have an increased risk of developing HCC. In order to examine this, we analyzed the amount of inflammation, an early sign of liver disease, in the livers of mice on a high fat diet and induced hypoxic environment. The mice in this study have a one-time injection of tumor initiator diethylnitrosamine followed by continuous administration of the promoter phenobarbital, a high fat diet, and a hypoxia chamber to house the mice for regulation of their oxygen intake, allowing us to mimic the OD seen in OSA. Livers were harvested and formalin fixed and paraffin embedded and macrophages were counted using H and E staining. Results indicated that the amount of macrophage clusters is greater in the combination group of high fat diet and induced hypoxia compared to the other treatment groups. Furthermore, we have observed that obesity and OD together cause severe damage to the liver, enhancing the risk of developing HCC. This study is a significant preclinical step in distinguishing mechanisms that may explain obesities and OSA's combined consequence in HCC.

Kimberly Cardenas

Cornell University

Ithaca, New York

mentors: Anna Ochoa O'Leary and Raquel Rubio-Goldsmith

Latin@ Immigrant Students and Racialization

Recent racially-charged legislation targeting the Latin@ community in the United States has incited discussion. Previous research has examined the racialized effects on vulnerable Latin@ populations but few have looked at more-privileged groups, such as international college students. This paper explores how immigrant students from Latin America perceive or accommodate their racialization, or a racial identity in the United States. Eleven Latin@ immigrant students from The University of Arizona were recruited from a snowball sample. The participants were at varying academic trajectories, with the majority being PhD students, and were interviewed at The University of Arizona about their experience as racialized subjects. The interview was divided into close and open-ended questions. Close-ended questions included participants' demographic information, information on participants' ethnic and racial identification. Two Likert-scale questions regarding frequency of travel to country of origin and hospitality were also used. Open-ended questions concerned participants' perception of feeling "welcome", on racism and discrimination, and lastly on their individual experiences with the outside world. Amongst several findings, we found that Latin@ immigrant students experience racialization to different degrees inside and outside the university. We gained insight into the participants' perception of racial dynamics in their home countries and found that their racial and ethnic identification are connected with their perception of racist phenomena.

Jin Collins

University of Texas - El Paso

El Paso, Texas

mentor: Charles Wolgemuth

Bacterial Cell Morphology: Rod-shaped bacteria that replicate faster grow longer (Belgrave & Wolgemuth, 2013)

It has been well known that faster rod-shaped bacteria replicate, the longer cells will be. Indeed, it has been shown that there is a linear relationship between the cell length and the replication rate in Escherichia coli. However, until recently, an understanding of how the biochemical reactions of cell wall synthesis lead to this somewhat counterintuitive relationship was lacking. Belgrave and Wolgemuth (2013) constructed a mechanochemical model that described the relationship between the cell length, the degree of cross-linkage, and the cell growth based on the fundamental physics and biochemical kinetics of synthesis. A simplified figure of bacterial cell growth was described the cell wall synthesis and the cell elongation. Based on the description, they derived equations to explain the relationship between the average cell length, the degree of cross-linkages, and the division rate of rod-shaped bacteria. The theoretical values that were obtained from this model were consistent with the experimental data, and it implied that severing and recross-linking were independently linked to insertion.

Johnston Corbett

University of Arizona

Tucson, Arizona

mentor: Eleni Hasaki

The Importance of Spatial Modeling in the investigation of Ancient Mediterranean Artisan workshops' Manufacturing Processes, Methods, and Allocation of Workforces

The field of archaeology has studied ancient structures in order to learn more about civilizations being investigated. The identification of ancient structures is extremely important in determining city layouts and planning as well as the technological abilities of a civilization. With the use of spatial modeling, archaeology can now look into the daily operations of structures such as ancient Greek pottery workshops and understand the division of labor while also determining exactly how the space of the workshop was used. Modeling ancient floorplans and production methods offers insight into spatial usage and production techniques of ancient artisans of varying crafts and locations and the gathered data has given insight into labor and material allocation of an ancient workshop. Spatial modeling allows for further investigation into specialization and trade of various artisan crafters throughout the Mediterranean. Data was collected from Moknine, Tunisia in 2011 by Dr. Eleni Hasaki, using pottery workshops whose traditional crafting practices and layouts allowed for comparison to the pottery structures of the ancient Greeks. The data showed in great detail the labor distribution, time spent on specific tasks and allocation of space throughout the 16 workshops observed. The information gathered by Dr. Hasaki will over time be compared to ancient pottery workshops throughout the Mediterranean and spatial modeling has the potential to inform us into the workings of ancient dye making and iron forging as well as other artisan production over the next decade.

Lidielisa Esquivel

University of Arizona

Tucson, Arizona

Mentors: Cecilia Rosales, Celina Valencia

Identifying HIV Prevention Programs in Mexico and Central America for Female Sex Workers (FSW): A Scoping Review

The objective for this study was to identify what is known from existing literature about current or discontinued HIV prevention programs conducted among female sex worker populations in Central America or Mexico. Female sex workers (FSW) constitute a large portion of the vulnerable HIV populations found in Central America or Mexico because of their high prevalence of intravenous drug use, risky sexual behaviors, and their susceptibility to violence within their personal relationships and with sexual clients. These risky behaviors are of great concern since studies have previously shown that most HIV positive individuals are unaware of their status and therefore are unconsciously spreading the virus. It was important to identify the mechanisms that position FSW at high risk for HIV in these limited-resourced regions that struggle to implement necessary HIV prevention programs. A scoping review was directed to analyze scholarly articles utilizing the electronic databases Pubmed, SciELO, and the VHL Regional Portal. The review initially assessed 301 published articles and of these, 14 studies were selected through the use of an inclusion/exclusion criteria. The studies demonstrated that previously established HIV prevention programs were found to have similar structures such as providing HIV and STI testing for their participants, promoting condom use and enhancing safer sex negotiation skills among female sex workers to reduce HIV risk. Public health agencies in these regions should continue to strive towards implementing HIV prevention programs in order to reduce HIV incidence rates in the future.

Kietzecume Garcia

University of Arizona

Tucson, Arizona

mentor: Ophelia Zepeda

Introduction of Mobile Language Application for Santa Ana Pueblo

This research project focuses on the theme of language revitalization within Native American languages indigenous to North America, specifically within the Santa Ana Pueblo. The rate of language loss facing these Native American communities is severe where almost 80% of the native languages are threatened (Norquest, 2015). The research focuses on analyzing technology based programs that other Native American communities facing language loss have developed in order to implement an effective technology based program for the Santa Ana Pueblo. Furthermore, this paper examines how technology assists users in language learning and presents a qualitative analysis of the Santa Ana Pueblo community members' attitude toward using technology as a tool to promote language learning through the use of a survey. The survey indicated that community members were willing to utilize technology and more specifically in order to promote language use among the younger generation of community members. This research serves as a starting point with the ultimate goal of developing a mobile language application for the Santa Ana Pueblo.

Galen Gudenkauf

University of Arizona

Tucson, Arizona

mentor: Anna Dornhaus

Task Allocation-body Size Relationships in the Ant Temnothorax Rugatulus

Social insects can vary widely in worker body sizes both within and among species. Body size variation is thought to increase colony fitness by allowing workers to specialize on tasks best suited to their size and physical attributes. This project determines whether body size predicts division of labor in the ant *Temnothorax rugatulus*. Across species, larger ants are often outside workers because they can carry more resources, travel faster, have better vision and use less energy for energetically costly tasks. A prior study determined that outside workers (termed “foragers”) are larger, but a more recent study found smaller outside workers. In this project, these two conflicting studies are compared to determine whether there is a general pattern that associates the different results by standardizing measurements of ants from both studies into body length (head-to-petiole length) and investigating body size-task relationships. Gaster width is measured with body length to determine corpulence, and a logistical regression is performed between body length and head width. Behavioral-task data is used to cluster individuals into task groups across 18 colonies and these groups are correlated with body size measurements. Demand is investigated, and a significant interaction is found between proportion of foragers and body size, but there is not a correlation between brood-to-worker ratio and task-body size relationships, nor is there an effect of number of queens or colony size on task-body size relationships.

Ellen Gilbert

University of Arizona

Tucson, Arizona

mentor: John Weins

Exploring Climatic Influence on Speciation

It is imperative to explore the relationship between climate and speciation in order to gain a deeper understanding of evolution. Research was conducted on the relationships between 270 phylogenetic pairs of species using a bioinformatic framework. The pairs were determined using data compiled by Quintero and Wiens in 2013. Using the statistical programming language R, minimum convex polygonal maps were created to show the habitat boundaries based on the available geographic data. This method on occasion provides an incomplete representation of a habitat therefore each species was checked against a database such as AmphibiaWeb or the IUCN Red List of Endangered Species before being labeled as allopatric, parapatric, or sympatric for the purpose of analysis. For the purposes of continuity a scale of 20 kilometers was implemented. If the habitats of a pair overlapped, they were considered sympatric; if they were 20 kilometers apart, they were considered parapatric; and if they were at a distance greater than 20 kilometers, they were considered allopatric. Bioclimatic information from the years 1960 to 1990 was aggregated with latitudinal data using an open source package available from WorldClim. The compiled data underwent analysis of variance tests in SysStat to explore the relationships between annual mean temperature, annual precipitation, and latitude. Amongst the 270 analyzed species, allopatrism was the most common mode of speciation. Results showed that the two analyzed bioclimatic variables did not significantly explain the dataset.

Marvin Hoo

University of Central Florida

Orlando, Florida

mentor: Matt Grilli

Self-Referential Cueing and Autobiographical Memory in Traumatic Brain Injury Adults

Autobiographical memory (AM) can be defined as memories distinct to an individual. The ability to retrieve detailed AM is commonly impaired in adults with traumatic brain injury (TBI). In a recent study, personal cues were found to enhance retrieval of AM in an adult with memory impairment secondary to stroke. The present study will investigate whether personal cues can help individuals with TBI recall detailed autobiographical events. Also, this study will investigate if the telling of detailed future events can be aided by personal cues. It is hypothesized that episodic (i.e. event-specific) detail will be enhanced when personal cueing is involved in remembering and imagining. Adults with TBI and healthy control participants will partake in an interview during which they are asked to recall memories and imagine future events using generic cues and personal cues. Personal cues will be comprised of activities they partake in regularly and stable aspects of their identity. Interviews will be transcribed and scored for episodic details and semantic details (i.e. not specific to the event). We expect results to show that TBI and healthy adults generate more episodic detail while recollecting the past and imagining the future when personal cues are involved relative to generic cues. Whether personal cueing closes the gap between TBI and control participants is an empirical question. If personal cueing is beneficial, further investigation could determine whether personal cues can be used by adults with TBI to improve the use of AM in social situations and to solve problems.

Mardo Lewis

University of Arizona

Tucson, Arizona

mentor: Hongki Jo

Investigating Sonar Technology for Monitoring Bridge Scour

The following research will briefly discuss the subpar quality of infrastructure in the United States and why it has been rated a D+ on an academic scale. Because infrastructure deals with an array of subtopics all equally important in their own way—roadways and sewer systems, water treatment, structural and city design, etc.—the research focus in the lab was monitoring the scour that occurs at the interface between a bridge's piers and a riverbed. Bridge scour is simply stated as the erosion of riverbed material surrounding a bridge's foundation. The lab utilized sonar technology (sound wave sensors) to detect the scour as it happened in real time. The technology was under an experimental setup to see how the combination of turbidity and turbulence created 'noise', or disturbance, in the measurements. In conjunction with these tests performed, there was a setup at a local bridge in Tucson, Arizona. This setup included a battery which powered the system, solar panels to charge the battery, a web antenna and router for data retrieval, cameras for visual monitoring, sensors for height measurements, and the sonar sensor placed near the riverbed in the direction that the scour would occur. Data was collected when there was enough rainfall runoff to create substantial flow. As data continues to be recorded and further lab tests are conducted, the preliminary results have led to a conclusion so far that the 'noise' which disrupts the accuracy of the measurements is entirely random.

Ashly Lona

University of Arizona

Tucson, Arizona

MENTOR: Laura Lopez Hoffman

Exploring the Relationship Between Institutional Arrangement and Outcomes in Payments for Ecosystem Services

Payments for ecosystem services (PES) are a developing conservation tool designed to engage actors to voluntarily invest in the restoration of the flow of ecosystem services in exchange for something of economic value. In pursuance of achieving superior outcomes for PES programs an institutional lens, which examines the basic organization and conduct of institutions, can be utilized to shed light on how PES policy design effects factors such as: environmental effectiveness, economic effectiveness, and equity. This research seeks to understand how the institutional arrangements of PES programs contribute to successful or unsuccessful outcomes. Our approach is grounded in the institutional analysis and developmental framework (Ostrom,2005) and examines 10 PES programs using deductive and inductive coding methods. A discrete qualitative comparative analysis is performed in order to draw linkages between the outcomes of PES programs and their rules and regulations. The results of our research illustrate how institutional analysis methods can enrich studies of PES program design. The conclusions of the study are expected to be published in the spring of 2017.

Leslie Ortega

Cal State Fullerton

Fullerton, California

mentor: Kelly Reynolds

Risk Communication and Perceptions of the Santa Clarita Valley Softener Ban

The Santa Clarita Valley Sanitation District (SCVSD) proposed an ordinance, Measure S, in 2008, which proposed to decrease the chloride concentration discharged into the Santa Clara River through the removal of all salt-based water softeners. This study aims to evaluate the environmental and social impacts of the water softener ban and to present a collective story of the water softener ban detailing pre- and post-ban events. To evaluate the environmental and social impacts of Measure S, an integrative review of various article databases and government websites was conducted. Measure S detailed various benefits for the residents and environment including, a rebate incentive in turn for water softeners, a decrease in the sewage tax rate and a reduction in chloride discharge levels. The results revealed an increase sewage tax rate and an insignificant reduction of the chloride discharge level. Thus, highlighting a gap in the communication between the SCVSD and the Santa Clarita residents, and indicating the need for environmental assessments before proposing legislation.

Michelle Perez-Coronado
University of Arizona

Tucson, Arizona

Mentor: Kelly Reynolds

Finding the Connection Between Hospital-Acquired Infections (HAIs) and Surfaces in Healthcare Settings: An Integrative Review

An integrative review was conducted to identify a connection between hospital-acquired infections (HAIs) and healthcare surfaces. There is no definitive statistical connection between healthcare surfaces and HAIs and research has predominantly focused on hand hygiene as an effective infection control measure despite the low compliance rate. The use of specific key terms and electronic search databases like PubMed, Google Scholar, and The University of Arizona Library online database yielded 54 articles. Only eight articles met the complete inclusion criteria that included: significant statistical data, highly infectious pathogens like MRSA, VRE, and C. diff, and prior room occupancy. Seven studies focused on the healthcare environment with the specific pathogens and one focused on general pathogens on healthcare surfaces. Overall, the P values recorded by these studies validate the connection between HAIs and healthcare surfaces. The P values for prior room occupancy for VRE and MRSA were 0.001 and 0.03, respectively. Also, general pathogens survive on different healthcare surfaces, such as the bedside table (P=0.03), alcohol hand gel pump (P=0.02), storage trolley (P=0.03). Additionally, the risk of contamination on hands of healthcare workers is the same, whether they directly touch the patient's skin or touch a surface (P=0.99). These findings imply a strong correlation between HAIs and healthcare surfaces, since they present another mode of transmission that is not well studied. The risk of HAIs cannot be completely eliminated but further studies on healthcare surfaces and HAIs can ensure the risk is reduced.

Eduardo Ramirez-Lopez

University of Arizona

Tucson, Arizona

mentor: Jesse Little

Dielectric Barrier Discharge Plasma Actuators for Active Flow Control

According to Roupassov, Nikipelov, Nudnova, and Starikovski (2009) accomplishing a clear understanding of Active Flow Control (AFC) by low temperature plasma actuators is considered a trending research topic among aerospace and fluid dynamics engineers around the world. Subsequently, there has been increasing interest in studies involving dielectric barrier discharge (DBD) plasma actuators for AFC and its benefits to engineering applications. Plasma actuators were initially considered useful only at low speeds; however, recent studies have proven that these devices are advantageous at different high subsonic, transonic, and supersonic speeds. The purpose of this research is to continue with the analysis of aerodynamic flow control with the implementation of nanosecond dielectric barrier discharge plasma actuators (ns-DBD), and construction of new wind tunnel walls for better image data analysis. A hinge model and its production was also necessary to provide support for the new wind tunnel structure. Glass walls were intended to replace the old acrylic walls in the wind tunnel laboratory to help us understand underlying physics related to the plasma actuator mechanism; however, the present research did not take place inside the wind tunnel as planned due to limited time. The plasma actuator was instead studied experimentally in quiescent atmosphere. Pulse energy and pulse power are calculated using voltage and current measurements simultaneously. Additionally, electrical characteristics are evaluated as a function of peak voltage, pulse amplitude, actuator length and dielectric thickness.

Gabriel Rodriguez, Jr.

San Jose State University

San Jose, California

MENTOR: Regina Deil-Amen

Latino Males Navigating Community College: The Intersection of Gender and Ethnicity

Latina/o's are the youngest, largest, and fastest growing demographic in the United States. At the same time, Latino males are also the least educated population throughout the educational pipeline from kindergarten through an undergraduate degree (Aborna & Nora, 2007; Cerna, Pérez, & Sáenz, 2009; Clark et. al., 2013; Sòlorzano, Villapando, & Oseguera, 2005). Previous scholars addressing this issue discussed how the enactment of gender caused lack of emotional openness, lack of seeking academic support, and a constraint on academics because of family obligations (Sáenz et al., 2013). However, this study seeks to address those findings while also trying to understand how the intersection of gender and ethnicity is relevant to Latino males' decisions to enroll, continue, and complete community college. This qualitative study focused on 10 semi-structured interviews from Latino males between the ages of 18 to 32 attending one community college in the Maricopa County Community College District in Arizona. Data were analyzed using descriptive coding and value coding to identify major themes from the interviews. This study aims to understand how the intersection of gender and ethnicity is relevant for Latino males who decide to enroll and navigate the community college system. In addition, explore how these spaces can address issues of impostor syndrome, lack of economic resources, and lack of mentorship for Latino males.

Felicia Saltwater

University of New Mexico

Albuquerque, New Mexico

mentor: Leah Fabiano -Smith

Diagnostic Accuracy in Bilingual Phonological Assessment: Preventing Health Disparities

This study looks at how bilingual children are currently being evaluated and addresses the need for more accurate diagnostic criteria. Development of this criteria is necessary in order to differentiate between typically-developing bilingual children from those with speech sound disorders. Between-language interactions will also be looked at to see if one language has an influence on the other. A total of forty-seven children, ages 3-6, have met specific inclusion criteria to participate in this study: twenty-five typically-developing bilingual children, sixteen typically-developing monolingual English speakers, four speech disordered bilingual children, and two speech disordered monolingual English speakers. Single word samples were collected and analyzed to derive phonetic inventories. A nonverbal IQ test was also conducted in order to determine the child's level of cognitive abilities. A normal distribution of nonverbal IQ scores were found for the sample. Phonetic inventories in both Spanish and English existed at the highest level of typological complexity in typically-developing children, corroborating past work examining bilingual 3-year-olds (Fabiano-Smith & Barlow, 2010). This study is ongoing and will provide normative data on the phonological skills of bilingual children and the recommended measures for accurate diagnosis of speech sound disorders in this population

Destiny Timmons

University of Arizona

Tucson, Arizona

mentor: Diane Austin, Nick Ferdinandt

The Context of Culture in an Intercultural Classroom

The purpose of the research was to identify an influence of culture in student learning and engagement in an intercultural classroom. The research was conducted in a center for English as a Second Language (CESL). The research calls attention to what might be overlooked as significant forms of learning, and to understand and take advantage of cultural occurrences that forms when studying in the context of an intercultural classroom. There has been more research on the importance of the cultural approach toward learning, without clearly defining exactly what are the cultural interactions and influences of the students in the classroom. The ethnographic methods of participant observation and interviewing were the main approach used for data collection. The field notes and interviews were then coded for major themes. The results of this analysis was used to identify three main themes that were most significant to the research question introduced. The major themes identified were then categorized into smaller specific themes according to ethnic identities ranging from three different groups; China, Saudi Arabia, and Other. Upon completion of this research data was most rich in themes such as gender roles, admiration for diversity, and strong connections between students. Conducting this research looks at how cultural appreciations operates in the context of a classroom and how it illuminates the idea of intercultural competence.

Minority Health Disparities (MHD)

Executive Director: Andrew Carnie, PhD Program Director: Stephanie Adamson

Program Co-Director: Holly Lopez

MHD, funded primarily by UA, focuses on health issues that a ect minority commu- nities in a disproportionate manner. Open to junior or senior bio- medical majors in- terested in continuing their education at the PhD level, MHD accepts students from other universities as funding is available.

Trenton Aguilar

University of Arizona

Tucson, Arizona

mentor: dr. Brett Colson, dr. Thomas Brunch

Preparing Truncated Cardiac Myosin-Binding Protein C Domains for Biophysical Analysis

The cardiac isoform of myosin-binding protein C (cMyBP-C) is a heart muscle protein that fine-tunes the contraction of actin and myosin. cMyBP-C has 11 domains numbered C0 through C10, but most of this protein's regulatory action to influence the heart's pumping occurs in the first three domains C0, C1, and C2 (i.e., C0-C2). We have used amino acid site-directed mutagenesis to truncate the C0C2 immunoglobulin (Ig)-like domains of cMyBP-C into smaller segments, C0C1 and C1C2. These C0C2 domains are hypothesized to have an important role in how cMyBP-C's function changes due to phosphorylation, so by separating the segments, the biophysical techniques of Fluorescence Resonance Energy Transfer (FRET) and Differential Scanning Calorimetry (DSC) can be used to analyze each sections' function and its contribution to the mechanism of the overall protein. We will also test the hypothesis that these domains bend in order to interact with each other. We verified the successful mutagenesis by gel electrophoresis and DNA sequencing. In order to express and extract the truncated proteins in bacterial cells, NEB5-α and BL21-DE3 strains of E. coli were transformed with the mutated DNA and grown up in cell culture growth media. After producing the protein in cells, these prepared stocks were then frozen for future purification by an affinity column chromatography and analysis by FRET and DSC. With analysis of these truncated proteins, we aim to understand how cMyBP-C functions with phosphorylation and apply this knowledge towards drug application and the treatment of hypertrophic cardiomyopathy and heart failure.

Oksana Angel Carlson

University of Arizona

Tucson, Arizona

mentor: Terry Matsunaga

Targeted Lipid Micro-bubbles for Detecting Pancreatic Cancer Using Multi-Microscopic Photo-imaging

Pancreatic cancer leads to many deaths each year primarily because it often goes undiagnosed until it is too late. Symptoms typically do not surface until the cancer reaches its advanced stages at which point surgical intervention is not beneficial. However, for those who may still benefit from surgery, pancreatectomies are challenging because of the difficulty in insuring complete tumor removal (i.e. clean margins). Currently, resected tissue from the margin is sent to pathology during surgery to determine if the residual tumor is present; prolonging operating time and increasing morbidity. To combat this, a new diagnostic procedure is being developed that could be used at the point of care to determine clean surgical margins. By utilizing targeted microbubbles that adhere to the upregulated plectin-receptors on pancreatic cancer cells, the surgeon can directly determine if residual cancer is still present. Multiphoton imaging (MPM) is being developed to identify microbubble presence on residual tumors. MPM is being adapted to image tissues rapidly and with high resolution. Absence of microbubble binding can confirm the establishment of a clean margin, and hence, complete removal of tumor burden.

Octavio Cordova

University of Texas, El Paso

El Paso, Texas

mentor: Jason Yuan

Investigating KCNA 3 (K2p 3.1) Expression Levels using Rat PAH Models

Pulmonary Hypertension (PH) is a type of high blood pressure that affects the arteries in the lungs and the right side of the heart. In Pulmonary Arterial Hypertension (PAH) the blood pressure in the arteries that go from your heart to your lungs is higher than normal. Pulmonary Vascular Remodeling and Pulmonary Vascular wall stiffness are some of the causes shown to lead to PAH. In PAH the causes behind the disease have not been 100% proven, but researchers are looking at different interactions between the lungs and the heart. PAH can be induced through many different pathways that involve both the heart and lung vasculature. In this study, we investigated the role of K_v channels and their effect on the pathogenesis of PAH. K_v1.3 expression levels from genomic DNA of the pulmonary arterial smooth muscle cells (PASMCs) were analyzed and compared them between healthy control rat models and diseased PAH models. After replicating the experiment, the results showed no major difference in the expression levels of KCNA 3 in comparison to healthy control rat and the diseased PAH rat models. Instead, the results demonstrated no difference in the expression levels when using genomic DNA, but further analysis can be done to determine if gene transcription or translation is altered in IPAH patients and involved in pathogenesis. This study also provides a foundation for researchers to go into further studies to determine if K_v channels have any additional function or part in the pathogenesis of PAH.

Anna Figueroa

University of Arizona

Tucson, Arizona

mentor: Torsten Falk, Brian McKay

The Secret Life of Exosomes: Localization of a Control Point for Protein Uptake

Exosomes are small extracellular vesicles that carry miRNA, mRNA, and proteins that are delivered to distant cells. Recent studies have produced evidence for the role of exosomes in controlling a variety of physiological pathways, but not without controversy. The object of our study is to explore exosome release and uptake, by examining the mechanism and specificity of uptake.
We used cells from different species and tissues; CHO-K1, MCF-7, and SH-SY5Y. Exosomes released into the media from cells were isolated by differential ultracentrifugation then labeled for microscopic observation. The cultured cells were exposed to isolated exosomes and analyzed for uptake. To investigate the mechanism of uptake, proteinase-k was used to test whether an exosome membrane-resident protein was necessary for uptake. We also tested if uptake was an active cells process by chilling the cells to -4ºC. Having observed that the cold trapped the bound exosomes on the cell surface, we sought to pull out the cell surface exosome binding receptor using magnetic antigen capture affinity chromatography.

The results of this study demonstrated that exosome uptake is not tissue or species-specific. Additionally, we illustrated that a protein on the surface of the exosome is required for uptake, and multiple proteins were identified as cell-surface binding proteins. Identifying which of these proteins is the ‘exosome receptor’ will be an ongoing research direction. This study may provide the foundation for the elucidation of exosome communication between cells, and may help in the development of exosome biomarkers of human disease.

Jacob Garlant

University of Arizona

Tucson, Arizona

mentor: Marvin Slepian

Stretchable Electronics Conformal Skin-adherent Wearable Patches: A Novel Method for Wireless Patient Monitoring

In our society, there exists an increasing population of elderly individuals that are cared for in chronic care facilities. In these facilities, the individuals are being monitored almost non-stop, creating the feeling of a lost independence. Ultimately, the goal of most elderly individuals is to remain in the comfort of their own homes, rather than attending these chronic care facilities.

Additionally, we live in a society where the rapid expansion of technological abilities has taken over nearly every aspect of our daily lives. These technological advances that encapsulate us on a daily basis have created a wide variety of connection with others and data sharing that would have seemed impossible only decades ago. Using this background information, the goal of this project is to utilize a new technological device with the hopes to create a method in which elderly patients can be monitored, without violating personally privacy, in the comfort of their own homes, while being able to maintain their sense of independence.

Using skin patches (BioStamp RC, MC10) placed on an identified fixated location of a subject (most commonly the subject's dominant hand between their thumb and index finger), a motion signature was created. The subject would complete a series of experiments following a detailed protocol for each of the different activities. After the data were collected, they were analyzed graphically using Matlab, looking for patterns in the X, Y, and Z axes.

Tyler Johnson

Brown University

Providence, Rhode Island

mentor: Nathan Ellis, Christelle de Renty

Interaction between SUMO-BLM and RAD51 via its SUMO-Interaction Motif

Mutation's resulting from defects in repair of DNA damage that occurs during DNA replication is a key factor in carcinogenesis. The BLM gene product helps maintain genomic integrity at damaged replication forks by regulating the recruitment and function of key repair factors, particularly RAD51 recombinase. In vitro, interaction between BLM and RAD51 is controlled by post-translational modification of BLM by SUMO-2. RAD51 contains a SUMO-interaction motif (SIM) identified at amino acid positions 261-264 (VAVV). We hypothesized that mutation of amino acids in the SIM would greatly reduce the interaction of RAD51 with SUMO-2 and sumoylated-BLM. To test this hypothesis, we produced a RAD51 mutant exchanging alanines for the valines at residues 263 and 264. We expressed both wild-type and SIM-mutant histidine-tagged RAD51 proteins in bacteria. After lysis, recombinant RAD51 proteins were purified via their His-tag by using cobalt-charged beads. Purified proteins were then analyzed by Western immunoblotting. We next optimized the RAD51 purification in order to get consistent levels of RAD51 immobilized on the beads. The next step is to test RAD51 interaction with SUMO-2 in a pull-down assay. We predict that the levels of SUMO-2 pulled down with normal RAD51 will be greater than the levels pulled down with SIM-mutant RAD51. In parallel, we will test the interaction of wild-type and SIM-mutant RAD51 with sumoylated-BLM protein. These experiments will test whether the SIM-mutant RAD51 has lost its ability to interact with sumoylated-BLM and will then allow us to analyze the effects of this mutation on cellular functions of RAD51.

Daniel Macias

University of Arizona

Tucson, Arizona

mentor: dr. Andrew Fuglevand, Alie Buckmire

Dependence of Electrically-Evoked Force on Intramuscular Electrode Location

Functional Electrical Stimulation (FES) is a widely used method to elicit muscular contraction in paralyzed muscle via excitation of motor axons supplying muscle. The modest production of contraction force generated by FES, however, is a major limitation. Explanations for such weakness in FES-evoked contraction are unknown. One factor that might contribute to this force deficit is the extensive dispersal of motor nerves within a muscle. This makes it difficult for a single electrode, as often used in FES, to activate the entire array of motor endpoints. The present study was designed to characterize this dispersion by electrically stimulating at multiple locations within a muscle. Three healthy human subjects (20-56 yrs) sat with their right foot fixed to an instrumented footplate which measured isometric force. Four intramuscular electrodes were inserted into the tibialis anterior ~ 2 cm apart along the length of the muscle. Contraction force was measured in response to current pulses (10 mA, 0.26 ms duration, 40 Hz for 1 s) delivered separately to each electrode and at different depths (10-28 mm below the skin surface). Evoked forces varied markedly with changes in depth as well as between electrodes. This result is consistent with the idea that intramuscular nerve branches are widely scattered within a muscle. Such a distribution would underlie multiple 'hot spots' for FES. Consequently, we propose that FES contractions could be greatly enhanced and the utility of FES improved by using multiple, rather than single electrodes.

Francisca Morales

University of Arizona

Tucson, Arizona

mentor: Kersten Reinschmidt

AzPRC CAB: The Driving Force to Healthier Communities

Arizona border communities are unique in terms of their environment and ethnic diversity. Yet these communities are medically underserved and are subject to health disparities. The Arizona Prevention Research Center (AzPRC), funded by the Centers of Disease Control and Prevention (CDC), has worked with border communities to identify and address chronic disease disparities for over 20 years. In order to reduce Arizona border health disparities, the AzPRC is closely working with a border-wide Community Action Board (CAB). The CAB represents the diversity of the border communities and guides the AzPRCs projects. The overall goals of my study were to understand how CAB members see their roles, and how the CAB represents the diversity of border communities. I conducted participant observation and open-ended interviews with a purposely sample of 9 CAB members. My findings revealed that the CAB and the AzPRC work closely together to improve the health of their border communities. Decisions related to the AzPRC research projects are very community-based participatory and community-oriented. The CAB represented the geographical, ethnic, gender, and public/ private health sector diversity of their communities served, but continues to reach out to communities currently not yet represented. The CAB is a driving force to healthier communities, and thus needs to maintain representative community membership. I recommend performing regular, formative CAB assessments of CAB member roles and diversity.

Natalie Munguia

University of Arizona

Tucson, Arizona

mentor: dr. Karen Herbst

Understanding Lipedema: The Fat Loss Resistant Condition Affecting Women

Lipedema is a painful subcutaneous adipose (fat) tissue (SAT) disorder that resists extreme nutritional, surgical and physical fat loss attempts. Lipedema SAT is located mostly in the gynoid region (hips, buttocks and legs) but the arms, and lower abdomen can also be affected. Lipedema can be confused with obesity and other SAT disorders; SAT can grow to great amounts damaging blood and lymphatic vessels, skin and muscle. Physically pushing on lipedema SAT causes an aching, stabbing, and bruise like feeling which is a marker suggesting a different kind of SAT. The objective of this project was to assist Dr. Herbst in writing an article on the adipose tissue disorder lipedema for the Canadian Lymphedema Framework magazine Pathways for the Fall 2016 issue. The article was completed; it provides a general overview of this misunderstood condition along with diagnostic information, imaging/testing, and treatment recommendations to help individuals suffering with lipedema, and health care providers better understand this disorder. More research is needed in order to understand this SAT disorder and create better treatments. This paper was written as part of the University of Arizona's College of Medicine Treatment, Research, and Education of Adipose Tissue (T.R.E.A.T) program, whose goal is to identify the cause of why lipedema SAT is resistant to lifestyle change and to guide treatment and prevention of lipedema.

George Njock

University of Arizona

Tucson, Arizona

MENTOR: DR. JOHN PURDY

Arginase-2 supports Human Cytomegalovirus replication

Human cytomegalovirus (CMV) is a β-herpesvirus that infects the majority of the global population. Infection of CMV is generally asymptomatic; however, in immunocompromised individual the virus may cause an array of clinical illnesses. Furthermore, congenital infection may also result in life-long disabilities. CMV, like all viruses, are cellular parasites and are dependent on host metabolism for the generation of energy and metabolites. Metabolic remodeling by CMV has been studied in the context of carbon utilization (e.g. glycolysis and fatty acid synthesis). We hypothesize that remodeling of nitrogen metabolism (e.g. urea cycle) is also important for infection. In this study we focused on the urea cycle enzyme Arginase-2 (Arg2) that converts arginine to urea and ornithine. Arg2 is located in the mitochondria, whereas its isoform Arg1 is located in the cytosol. Arg1 is commonly thought to perform most of the arginase activity in cells and the role of Arg2 is poorly defined. Arg2 may also regulate nitric oxide ($NO^{\cdot}$) production. Our overall goal is to determine if Arg2 controls urea and $NO^{\cdot}$ synthesis during infection. First, we determined how Arg2 protein levels are altered by CMV. Importantly, we also examined the effect of viral replication by using shRNA to knockdown Arg2 activity. Overall, our findings showed that Arg2 supports CMV replication. Future studies are required to determine if infection is altered by Arg2 role in nitrogen metabolism or its role in limiting $NO^{\cdot}$ biosynthesis.

Laura Paredes

University of Cal-East Bay

Hayward, California

mentor: dr. John Streicher, Wei Lei

The Effect of High Dose Heat Shock Protein 90 Inhibition on Opioid Induced Signaling and Behavior

Heat shock protein 90 (Hsp90) is a ubiquitous regulator for many signaling pathways and proteins. Only 2 previous studies suggested that Hsp90 might be involved in the regulation of opioid receptor signaling and pain. Previously, our laboratory demonstrated that inhibiting Hsp90 activity with a low dose of inhibitor (0.5 nmol 17-AAG) in mice increased Hsp70 expression and decreased opioid-induced ERK MAPK stimulation in the brain, and decreased opioid induced anti-noceciption (tail-flick) and increased opioid induced acute and chronic dependence. This study was designed to determine the effects of a higher dose of 17-AAG on μ-opioid receptor (MOR) signaling in the mouse brain and on opioid induced tail flick and acute dependence. We thus injected CD-1 mice intracerebroventricularly with 5 nmol 17-AAG for 24h, followed by the injection of vehicle or the opioid agonist DAMGO (0.1 nmol) into the brain. As expected, we found decreased ERK activation along with increased Hsp70 expression in the periaqueductal grey, however, the effect is similar to that seen with 0.5 nmol of 17-AAG. We also found a modest increase in jumps, and no change in the weight of urine and feces, after naloxone precipitated withdrawal during acute dependence. Furthermore, treatment with 5 nmol 17-AAG showed no impact on the acute anti-nociceptive tail-flick response to DAMGO. These findings demonstrate that increasing the dosage of Hsp90 inhibitor has less impact on the signaling of the MOR compared to that from the lower dose, suggesting how Hsp90 modulators could be used to improve opioid therapy in pain patients.

Alejandra Pina

University of Texas, El Paso

El Paso, Texas

mentor: Heidi Mansour

Improvement of In Vitro Aerosol Dispersion Performance by Using Mannitol in Dry Powder Inhaler Formulations

Pulmonary drug delivery of both targeted and systemic treatments has become a mechanism of interest, due to key physiological features of the respiratory tract. Dry powder inhalers (DPIs) offer advantages for the delivery of inhalable drugs, including improved stability of formulated drugs and the delivery of poorly water soluble compounds. Mannitol (Man) is an FDA-approved, non-reducing sugar alcohol shown to improve in vitro aerosol performance of inhalable drugs as powders, therefore improving the drug's therapeutic performance. This study compared two different drugs from two distinct therapeutic classes formulated with and without Man as DPIs. The DPIs were engineered using organic solution advanced spray drying technique in closed-mode. Single component spray dried (SD) systems consisted of dimethyl fumarate (DMF) and tetramethylpyrazine (TMP). Moreover, multicomponent co-spray dried (co-SD) systems at various ratios consisted of the respective drugs and Man. The in vitro aerosol dispersion performance was conducted using the United States Pharmacopeia (USP) Next Generation Impactor (NGI™) with the HandiHaler® and the Aerolizer® FDA-approved human DPI devices. The results showed improvement in in vitro aerosol dispersion performance with the co-SD DMF:Man and TMP:Man DPIs over the SD drugs. The percent of Fine Particle Fraction (FPF %), Respirable Dose (RD %), and Emitted Dose (ED %), substantially increased with the incorporation of Man in the molecular mixtures. Additionally, the Mass Median Aerodynamic Diameter (MMAD) significantly decreased with the addition of Man.

Alejandra Piña, Carissa L. Grijalva, Maria F. Acosta, Alexan I. Gomez, Priya Muralidharan, Don Hayes, Jr, Jason X.L. Yuan, Stephen M. Black, and Heidi M. Mansour.

Angelica Quinones

University of Texas, El Paso

El Paso, Texas

mentor: dr. Nancy Horton

DNA Binding to Viral and Host DNA by the Nuclease Domain of the Main Replicative Protein NS1 from the Human Parvovirus B19

Human Parvovirus B19 (B19V) is a single stranded DNA virus known to infect the majority of the population (50-80%). Most cases involve school-aged children with the development of erythema infectiosum, which in most cases is a mild and short-term infection with possible rash symptoms. In addition, B19V can cause serious conditions such as hydrops fetalis, transient aplastic crisis, and myocarditis. Interestingly, B19V has also been associated with several autoimmune diseases such as lupus and arthritis in adults. Proposed mechanisms for autoimmunity involve the function of the non structural protein (NS1), the main replicative protein of B19V. Functional studies of the nuclease domain of NS1 can deliver significant information about its specificity for DNA binding and cleaving of both viral and host DNA. In this investigation, the interaction between the nuclease domain of NS1 with the nonstructural binding elements (NSBE) of the viral DNA as well as a host DNA promoter region, p21, was assessed via sedimentation velocity and equilibrium experiments in a analytical ultracentrifuge. Results show that multiple nuclease domains of NS1 binds to both the NSBE as well as specific regions of the p21 sequence. With these results, we can obtain a model for nuclease binding to both viral and cellular host DNA which could prove useful for understanding the underlying mechanisms of the possible autoimmune symptoms.

Marisela Rodriguez

University of Arizona

Tucson, Arizona

mentor: Jason Yuan

Downregulation of Pro-apoptotic Protein Bax in Pulmonary Artery Smooth Muscle Cells from Patients with Idiopathic Pulmonary Arterial Hypertension.

Pulmonary arterial hypertension (PAH) is a progressive and fatal disease characterized by elevated pulmonary arterial pressure (PAP) and pulmonary vascular resistance (PVR). Idiopathic PAH (IPAH) is a rare form of the PAH with unidentifiable etiology. Pulmonary vascular remodeling constitutes a major cause for the increased PVR due mainly to excessive proliferation and inhibited apoptosis of pulmonary artery smooth muscle cells (PASMCs). The Bcl-2 family proteins are traditionally believed to reside or translocate to the mitochondria and function as apoptotic regulators by controlling the release of cytochrome-c from the mitochondria. The ratio between anti- (Bcl-2, Bcl-xL, Mcl-1, HAX-1) and pro-apoptotic (Bax,Bak, Bid, Bim) Bcl-2 family proteins determines whether cells live or die. Here, we examined whether anti-apoptotic Bcl-2 protein is upregulated and/or pro-apoptotic Bax protein is downregulated in IPAH PASMCs in comparison to normal PASMCs.Western blotting data shows that the protein expression level of anti-apoptotic protein Bcl-2 was low and showed a significant difference in or between normal and IPAH PASMCs; additionally, pro-apoptotic protein Bax was downregulated in IPAH PASMCs in comparison to normal PASMCs; and thus, Bcl-2/Bax ratio is increased in IPAH PASMCs compared with normal PASMCs. Together, the data suggest that pro-apoptotic protein Bax is downregulated and potentially has a significant role in the excessive proliferation and inhibited apoptosis of PASMCs in patients with IPAH.

Maximizing Access to Research Careers

Primary Investigator: Megan McEvoy, PhD
Co-PI: Maria Teresa Vélez, PhD

Coordinator: Cindy Neal, MEd
Co-PI: Marc Tischler, PhD

Mazimizing Access to Research Careers (MARC), is a unique research, mentoring, nancial, and academic opportunity for UA undergraduates belonging to a group considered underrepresented in biomedical research and who have a and potential to pursue a career in this broad eld. Bene ts include training and nancial support for the last two years of enrollment at UA. MARC Trainees from other schools are invited to participate in MHD, which meets jointly with the MARC program during the summer.

Paul Acosta

University of Arizona

Tucson, Arizona

mentor: Mark "Marty" Pagel

Measurement of Tumor Acidosis Using Magnetic Resonance Imaging (MRI) and Machine Learning

Tumor acidosis, the decrease in extracellular pH of a tumor, is a consequence of altered metabolism. Low pH levels have been linked to contributions to tumor growth, invasion, and metastasis. These low levels can lead to chemoresistance and can be a target of alkalinizing therapies. Noninvasive measurements of the extracellular pH of the tumor microenvironment can improve diagnoses and treatment decisions. The purpose of this study is to improve upon the noninvasive methods of identifying tumor acidosis by integrating MRI chemical exchange saturation transfer (CEST) and T_2 exchange with machine learning pattern recognition and prediction algorithms. The chemical exchange rate that affects the CEST image contrast depends on physiological parameters that characterize the microenvironment such as temperature, pH, and metabolite concentration. Using the exchange rate, we can determine the pH of the observed system. However, the metabolite concentration that reaches the system can only be estimated, which decreases the accuracy of the measurement. Our goal is to develop a program that identifies the patterns and relationships between the CEST parameters and the T_1 and T_2 relaxation constants, and uses that data to predict the exchange rate of water with the agent molecules independently of concentration. This method will be translated to clinical use in order to improve the efficiency and accuracy of noninvasive tumor pH measurements, thus allowing for better diagnoses and treatment decisions.onary artery smooth muscle cells (PASMCs). The Bcl-2 family proteins are traditionally believed to reside or translocate to the mitochondria and function as apoptotic regulators by controlling the release of cytochrome-c from the mitochondria. The ratio between anti- (Bcl-2, Bcl-xL, Mcl-1, HAX-1) and pro-apoptotic (Bax,Bak, Bid, Bim) Bcl-2 family proteins determines whether cells live or die. Here, we examined whether anti-apoptotic Bcl-2 protein is upregulated and/or pro-apoptotic Bax protein is downregulated in IPAH PASMCs in comparison to normal PASMCs.Western blotting data shows that the protein expression level of anti-apoptotic protein Bcl-2 was low and showed a significant difference in or between normal and IPAH PASMCs; additionally, pro-apoptotic protein Bax was downregulated in IPAH PASMCs in comparison to normal PASMCs; and thus, Bcl-2/Bax ratio is increased in IPAH PASMCs compared with normal PASMCs. Together, the data suggest that pro-apoptotic protein Bax is downregulated and potentially has a significant role in the excessive proliferation and inhibited apoptosis of PASMCs in patients with IPAH.

Sophia Aguirre

University of Arizona

Tucson, Arizona

mentor: dr. Greg Rogers

Understanding the Functions of Different 3-Dimensional Genome Organizations

Recent studies identified the condensin II subunit Chromosome-associated Protein H2 (CapH2) as a master-regulator of chromosome territory (CT) formation in Drosophila melanogaster. Specifically, Cap-H2 overexpression or expression of non-degradable Cap-H2 in interphase cells disrupts homologous chromosome pairing, inducing chromosome individualization and the formation of distinct CTs. By manipulating this new regulatory pathway, it is now possible to investigate the function of different 3-dimensional chromosome organizations in cells by comparing the expression patterns of cells containing paired chromosomes to those with CTs. To obtain cells containing CTs we generated stable, inducible Schneider 2 (S2) cell lines that express wild-type (WT) Cap-H2. Cells were scored for the formation of normal, weak, and strong CTs over a six day time course. We also conducted cell viability counts on CapH2-expressing cells to determine the effect of CTs on cell health. We found that strong CT formation was most prevalent after six days of Cap-H2 expression. However, cell cultures expressing WT Cap-H2 displayed a reduced number of viable cells over the six day time course. Taken together, we conclude that it requires almost a week of WT Cap-H2 induction for most stable cells to form CTs and cause reduced cell health. At present, we are making stable lines expressing non-degradable Cap-H2 in order to induce faster genomic reorganization so that we can examine CT function.

Marisa Becerra

University of Arizona

Tucson, Arizona

MENTOR: Gene Alexander

Relation of Mean Arterial and Pulse Pressure Measurements to Cognitive Performance in Healthy Older Adults

Understanding the factors that contribute to successful aging has long been of interest to the scientific community. One factor thought to impact differences in cognitive function as adults' age is blood pressure. This study evaluated whether there was an association between mean arterial pressure and cognition, as well as pulse pressure and cognition, in a sample of healthy, older adults. We also examined if there was an interaction between gender and blood pressure measurements. Two hundred and eight adults, aged 50-89, completed a battery of neuropsychological tests that included measures of global cognitive function, memory, processing speed, executive function, and language. After controlling for age, education, and hypertension status, mean arterial pressure was found to have a positive association with performance in measures of language and processing speed, but was not associated with memory, executive function, or global cognitive function. There were no significant effects for pulse pressure, but there was a trend for higher pulse pressure resulting in poor performance on global cognitive function. In addition, there were significant gender differences observed in all of the tested cognitive domains, except for language, but no interactions were found between gender and blood pressure measurements. However, females were found to have a significant relationship between mean arterial pressure and scores on language and processing speed tasks, whereas males showed no significant relationship. Overall, these findings provide preliminary support for the importance of mean arterial pressure and gender as factors that may influence observed differences in cognitive aging.

Emanuel Bustamante

University of Arizona

Tucson, Arizona

mentor: Joanna Masel

Stop-codon Read-through Rates and Evolvability

Selection can act on genetic variation to increase the frequency of traits that make individuals more fit in their immediate surroundings. The ability to generate potentially adaptive genetic variation, or evolvability, is itself a heritable trait. Populations with high evolvability can adapt more rapidly to environmental change than less evolvable populations, potentially providing a selective advantage in a rapidly changing environment. We look to cryptic sequences as a source of variation affecting evolvability. Cryptic sequences are sections of genes translated on the rare occasion that a ribosome reads through a stop-codon. Because cryptic sequences are not expressed often, selection on them is fairly weak, so changes in cryptic sequences are often driven by genetic drift and mutation bias. The expression of deleterious mutations in cryptic sequences results in maladaptive variation while the expression of benign mutations in cryptic sequences results in potentially adaptive variation. Benign cryptic sequences then contribute to evolvability while deleterious ones do not. We seek to determine if pressure to adapt to a changing environment can drive a population toward evolving more benign cryptic sequences and therefore becoming more evolvable. To do so, we developed an agent-based model with sexual recombination.

Jose Celaya-Alcala

University of Arizona

Tucson, Arizona

mentor: Timothy Secomb

Effects of Changing Michaelis-Menten Kinetic Parameters on Tissue Oxygenation and Hypoxia

The dependence of oxygen consumption in tissue on partial pressure of oxygen (PO_2) can be described by the Michaelis-Menten equation. One of the parameters in this equation, the Michaelis constant P_0, gives the tissue PO_2 at half-maximal consumption. The literature contains disparate estimates of P_0. Tissue that is not receiving enough oxygen is called hypoxic. In this study we used theoretical simulations to investigate the effect of varying the assumed value of P_0 on the predicted amount of hypoxia in tissue. Tissue whose PO_2 is less than P_0 was considered hypoxic. Utilizing a Green's function approach, we simulated oxygen transport in a small region of tissue in a rat tumor. The value of P_0 was varied from 1 to 10 mmHg while all other parameters were held constant, with oxygen demand set to 0.0005 $cm^3O_2/cm^3/s$. The distribution of PO_2 was computed for each P_0 value. When P_0 was increased from 1 to 10 mmHg, the computed mean PO_2 in the tissue increased from 5.4 to 11.4 mmHg, while the amount of hypoxia in the tissue increased by 13.41%. In conclusion, we found that the value of P_0 has a significant effect on the predicted amount of tissue hypoxia. Increasing the value of P_0 causes an increase in mean tissue PO_2 because oxygen consumption at a given PO_2 is decreased, but the hypoxic fraction of tissue increases because more tissue is below the level at which consumption is half-maximal.

Olivia Nicole Gorushi

University of Arizona

Tucson, Arizona

mentor: Andre-Denis Wright

Analyzing gut microbiota of the American black bear (Ursus americanus)

Hibernation is a form of torpor during which animals enter a period of decreased metabolism to conserve energy. While a variety of small mammal species have been studied to observe how torpor affects their gastrointestinal tract (GIT) microbiota, similar effects in large hibernating mammals, such as bears, have received little attention. Most bear species undergo three stages of a hibernation cycle: active, hyperphagic (or pre-hibernation), and hibernation. Because these periods exhibit different dietary and metabolic patterns, we analyzed American black bear (U. americanus) feces obtained during active and hyperphagic periods to determine whether there was a correlated change in the microbial diversity of their GIT. During the course of this ongoing study, we will employ a repeated bead-beating DNA extraction technique, real-time PCR, DNA sequencing, and bioinformatics software to analyze the change in microbial diversity of the GIT between two stages of hibernation.

vBecause bears gain and lose large amounts of weight without detrimental effects to their health, exploring their GIT microbiota may help us understand more about obesity in humans, and lead us to new ways of treating obesity. Additionally, by undertaking this study, we hope to increase our understanding of the costs and benefits of implementing torpor in an effort to increase the quality of life of bears in captivity.

Daniel Osorio-Méndez

University of Arizona

Tucson, Arizona

mentor: Frans Tax

Regulation of Root Growth in Arabidopsis thaliana

Plants employ long-distance signaling mechanisms as a method of communication between the shoot and the roots. These long-distance signals communicate the nutritional status of the environment in which the plant resides and allow plants to optimize their growth and energy expenditure under suboptimal conditions. CEPs, CLEs, and HY5 are types of small-secreted peptides involved in the three currently known mechanisms of long-distance signaling in Arabidopsis thaliana. The purpose of this study is to characterize the genetic relationship between the signaling pathways involved in the regulation of lateral root growth in Arabidopsis. To accomplish this, we screened for double and triple mutant specimens of the receptors involved in these pathways in order to conduct epistatic analyses and as a way of diminishing genetic redundancy. The anticipated outcome of this experiment is the identification of a genetic pathway of root development regulation involving the above-mentioned receptor-coding genes as well as those genes coding for their respective binding peptides. The outcome of this project may have major implications in crop yield efficiency and other agricultural aspects.

UROC Prep
Student Affairs Research Program

Executive Director: Andrew Carnie, PhD
Program Director: Donna Treloar, MA

Program Director: Nura Dualeh, MA
Faculty: Andrew Huerta, PhD

Student Affairs Research Program (STAR),funded by UA Student A airs in partnership with the UA Graduate College, is open to UA juniors and seniors of all disciplines, including social science, humanities, ne arts, and STEM. This program is open only to UA students. **UROC-PREP,** funded by the University of Arizona, is a highly structured academic, mentoring, and research program for undergraduate students at the University of Arizona. All students in the year-round program come from backgrounds that are underrepresented in graduate education and are interested in pursuing research oriented graduate degrees (Master's or PhD).

Morgan Beckett

University of Arizona

Tucson, Arizona

mentor: Steven Schwartz

Elucidating the Allosteric Mechanism of Calcium Binding and the Implications for the Full Cardiac Thin Filament Model

The cardiac thin filament (CTF) protein plays an integral role in the coordinative mechanism of muscle relaxation and contraction on an atomistic level. This multi-subunit protein remains the site at which the allosteric mechanism of calcium (Ca^{2+}) binding and dissociation occurs within the cardiac troponin C domain; a site where dysfunctional calcium interactions can hold adverse implications for diseased-cardiac states. Despite the crucial regulatory role of Ca^{2+} interactions within the CTF, the precise atomistic mechanism for these interactions and their functional implications for the full CTF remain unclear. By isolating the cTnC from the full CTF model, we conducted computational experiments employing steered molecular dynamics and transition path sampling in order to elucidate the functional Ca^{2+} binding and dissociation mechanism of this rare event. Understanding the transition from the bound to dissociated stable state will provide insight for subsequent testing that will encompass the full CTF model. This will ultimately allow for the observation of the global implications that this local allosteric mechanism holds. In identifying the natural mechanism of Ca^{2+} interaction within the CTF, there lies the potential for precise characterization of dysfunctional Ca^{2+} binding and future application for drug design.

Angela Cruze

University of Arizona

Tucson, Arizona

mentor: Francesa Lopez

A Decade After Arizona SEI Teachers Perspectives on Implementation of SEI and Alternative Approaches

A decade has passed since the Arizona ELL Task Force mandated the implementation of the Structured English Immersion (SEI) 4-Hour Block program model to meet the linguistic and academic needs of Emergent Bilingual (EB) students. The intention of the current SEI program is for EBs to rapidly acquire English-language skills within one academic year. However, EB graduation rates continue to suffer, indicating an issue with the SEI policy and the programs' ability to meet EB students linguistic and academic needs. Previous research has investigated the current SEI program model and policy; however, limited research has explored EB teachers' perspectives in implementing the SEI program. The current study seeks to build on prior research, specifically investigating EB teachers' perspectives of the opportunities and the restrictions in implementing the current SEI program, as well as investigating EB teachers' recommendations for changes to the current program model. Using data collected from the Arizona Department of Education Latino Advisory Committee's spring EB Summit, an exploration of EB teachers' responses indicated the following prevailing themes: (1) Curriculum, Content, and Pedagogy; (2) Teacher Considerations; (3) Student Considerations; (4) Data and Documentation; (5) Professional Development and Training; and (6) Outliers. The salient themes were then compared with extant literature in order to recommend changes to the policy detailing teachers' needs.

Vanessa De La Cruz

University of Arizona

Tucson, Arizona

mentor: Gary Schwartz

Effects of Mindfulness Programs on Self-Efficacy within Homeless Youth: Heart Assisted Therapy Combined with Best Self-Visualization

The current study aims to explore the effects of mindfulness-based programs on the self-efficacy within the homeless youth population. This study is specifically aimed towards attaining data pertaining to the increase of self-efficacy once the mindfulness based programs are administered. The population for the current study consists of homeless youth ages 18-25 years old. The mindfulness-based programs being utilized are Heart Assisted Therapy and Best Self Visualization. The study utilizes within group T-tests with pre and post test questionnaires to collect data during the program sessions. The purpose of the study is to utilize said mindfulness-based programs, which incorporate integrative and mindfulness-enhancing approaches to psychotherapy that operate within a holistic mind-body-energy paradigm combined with traditional psychotherapy and energy psychology approaches, in order to discover a method to assist homeless youth in attaining higher self-efficacy while also potentially aiding them in reintegration into academia or the workforce. The current research on mindfulness-based therapy indicates a correlation between mindfulness and increased self-efficacy. Studies also maintain that high self-esteem is a large predictor of higher rates of life satisfaction, specifically in areas such as academia and work related endeavors. This study asserts that mindfulness-based programs may be beneficial to at-risk populations and researching its effects would be of great benefit to the area of mindfulness research. By providing mindfulness-based therapy to at-risk populations not only will research in the area of mindfulness be advanced, but if positive results are discovered said programs may be generalized and potentially utilized within various populations.

Jesus Del Rincon

University of Arizona

Tucson, Arizona

mentor: Cho Lik Chan

Stirling Engine Efficiency with a Regenerator

The Stirling engine is known for its high efficiency therefore; this study presents the test results of an MIT 2.670 Stirling engine. Stirling engine is built according to the plans. The engine was studied from both a kinematic and thermodynamic perspectives. Experiments were conducted by increasing the input power which allowed the work output to change. Furthermore, different temperatures measurements and power output estimates were made. With the use of this data a relationship between the power input and output could be analyzed. A regenerator was also conceptualized in the engine and due to the heat transfer characteristics a better output power could be achieved. The results of the experimental measurements are presented further the regenerator concept would be reviewed.

Khody Denton

University of Arizona

Tucson, Arizona

mentor: Brint Milward

The Islamic State of Iraq and Syria: Identifying Factors of Resiliency

Dark network research aims to identify the factors that enable terrorist organizations and other criminal groups to operate effectively. The Islamic State of Iraq and Syria (ISIS) is a vast, covert terrorist organization in the Middle East that threatens the national security of the United States and the well-being of its citizens. The purpose of this study is to enable policy makers, members of the intelligence community and the military to develop the best course of action in order to disrupt the ISIS network. This study uses open-source data available on the Internet and coding as the method of analysis to identify the factors that contribute to ISIS resiliency. Resiliency is attributed to the ISIS network's ability to resist and recover from any attacks affecting operational capabilities (Bakker, Raab, and Milward, 2012). The factors of ISIS resiliency identified in the results were placed under three categories: infrastructure, psychological operations, and adaptive network strategies. The control of infrastructure enables ISIS to generate revenue and maintain operational capability. Psychological operations includes the terrorist organization's ability to invoke fear, spread religious propaganda and recruit vulnerable individuals. Adaptive network strategies includes the ability to reorganize the structure of the network and the ability to change its warfare tactics. These factors can help guide the U.S. in understanding the ISIS network and the ways it can be disrupted.

Elena Dosamantes

University of Arizona

Tucson, Arizona

mentor: Mitch McClaran

Wild Horses and Burros: Population Growth Rates and Influencing Factors

Wild horses and burros are not native species to America. Their presence causes serious damage to the ecosystems they inhabit by affecting soil, water, vegetation, and other animals. Currently, wild horse and burro populations are approximately double what federal rangelands can sustain. Additionally, their numbers continue to increase at alarming rates. Every fiscal year the Bureau of Land Management (BLM) releases four reports concerning wild horses and burros. In this study, data was used from two reports: "Completed Gathers" and "Herd Areas (HA) and Herd Management Areas (HMA)". Data acquired from the reports for the past six years was HMA name, HMA acreage, estimated wild horse and burro populations, number of animals removed, and population inventory years. Population growth rates for both wild horses and burros were calculated with the previously mentioned data and the population growth rate model $rt=\ln(N_{t+1})-\ln(N_t)$ (Vucetich, Smith, Stahler, & Ranta, 2005), where rt represents population growth rate, Nt_{+1} is estimated population, and Nt is the previous year's estimated population. The University of Arizona's Standardized Precipitation (SPI) Explorer Tool was used to acquire precipitation data from the two years prior to population inventories. Using scatterplots, we assessed the relationship of wild horse and burro population growth rates with animal density and precipitation. It was found that as wild horse density and SPI increase so do wild horse population growth rates. On the other hand, when wild burro density increases so do wild burro population growth rates, but as SPI increases population growth rates decrease.

Jeremy Elias

University of Arizona

Tucson, Arizona

mentor: Erica Corral

Effects of Changing Michaelis-Menten Kinetic Parameters on Tissue Oxygenation and Hypoxia

The oxyacetylene torch is investigated through emission spectroscopy to determine the chemical composition as well as the behavior of high temperature materials in the flame environment. This characterization is performed to validate the oxyacetylene torch method as an effective screening method to simulate the response of materials in a hypersonic flight environment. The gathering of time-resolved emission spectra allow for the discussion of chemical processes on the sample surfaces. Graphite and ZrB_2-SiC composites are tested and their emission spectra captured in order to further validate the oxyacetylene torch testing method. The presence of the OH* band system as well as H_2O and CO_2* as well as other excited molecules are expected upon analysis of the flame spectra. Additional amounts of CO_2* and CO are expected in the graphite spectra, and Si and B concentrations are expected in the spectra of ZrB_2-SiC composite tests. The information gathered by the collection and analysis of time-resolved emission spectra can aid in developing an understanding of the oxyacetylene torch environment, which is something that is lacking in the context of material testing.

Emily Evans

University of Arizona

Tucson, Arizona

mentor: Marvin Slepian

Helminth Therapy as a Novel Treatment for Autoimmune Disease: Laboratory Viability of the Necator Americanus Human Hookworm

Autoimmune diseases have become a serious health problem in industrialized countries, with costly medical treatments often associated with serious side effects. Helminthic therapy is a novel alternative to traditional medicinal treatments for many common autoimmune diseases and disorders like rheumatoid arthritis, asthma, and some allergies. The use of helminths, or human hookworms, as an autoimmune therapy has proven its efficacy in clinical trials and other studies, but commercial implementation is difficult due to the highly infectious nature of the organism and the comprehensive FDA approval process. This study focuses on the species Necator americanus and outlines the steps needed to safely commercialize the helminth for therapy, beginning with the development of a test for larvae viability, defined as motility. The motility assay employs a heat source and an agar channel to determine the larvae's ability to detect and move toward their simulated host in a laboratory setting. The behavior of the larvae was carefully recorded in order to obtain useful data on their movement under controlled conditions. Once proven successful, this method will become the standard test for hookworm larvae viability in future experiments as the development of this therapy progresses.

Marisa Gonzalez

University of Arizona

Tucson, Arizona

mentor: Eduardo Saez

Hydrogen peroxide photolysis in a continuous-flow reactor

Hydrogen peroxide UV photolysis (UV/H_2O_2) is an Advanced Oxidation Process (AOP) that can be used as a tertiary wastewater treatment method that reduces trace organic contaminants (TOrCs). As the world population grows, the need to reuse water also increases in order to meet the needs of the public. In order to make water reuse possible, TOrCs need to be eliminated from waste water. Nonylphenol, a surfactant, is the TOrC that is the focus of this study and p-cresol is used as a nonylphenol substitute. While previous studies have focused on UV/H_2O_2 in batch reactors, this study focuses on continuous flow reactors which are more common in industry. The experiments were performed in a cylindrical continuous flow reactor with a UV lamp protected by a quartz sleeve. The concentration of p-cresol was measured using fluorescence spectroscopy and the concentration of H_2O_2 was found using UV spectroscopy. The preliminary results found that UV/H_2O_2 in a continuous flow reactor significantly degrades p-cresol over time.

Carissa Grijalva

University of Arizona

Tucson, Arizona

mentor: Heidi Mansour

Comparison of the In Vitro Aerosol Dispersion Performance of a Nrf2 Activator using Two Different Human Dry Powder Inhaler Devices

Drug delivery via the respiratory tract is first-line therapy used clinically in the treatment of pulmonary diseases. Dry powder inhalers (DPIs) offer many advantages over other drug delivery systems commonly used in pulmonary drug administration. In this study, we examined the dry powder inhalation aerosols of dimethylfumarate (DMF), a first-in-class fumaric acid ester FDA-approved drug known to possess Nrf2 activation properties, and mannitol (Man), a mucolytic non-reducing sugar alcohol. These were co-spray dried (co-SD) using a closed-mode advanced spray drying system and a high performance cyclone at different rationally designed molar ratios of DMF and Man to formulate inhalable dry powder aerosols. The in vitro aerosol dispersion performance (i.e. aerodynamic properties and aerodynamic size distribution) of these engineered co-SD powders was conducted by inertial impaction employing the USP (United States Pharmacopeia) Next Generation Impactor™ (NGI™) with two different FDA-approved human DPI devices, the Neohaler™ and the Aerolizer®. Both DPI devices are unit-dose capsule-based inhalers that possess different specific internal resistance and anatomical geometric features. As shown by the percent of emitted dose (ED%), percent of fine particle fraction (FPF%), percent of respirable fraction (RF%), and mass median aerodynamic diameter (MMAD), for this specific co-SD system (DMF:MAN), the Aerolizer® DPI device exhibited optimal aerosol performance over the Neohaler™ DPI device.

Genesis Grijalva

University of Arizona

Tucson, Arizona

mentor: Charles Adams

Ceramic Figurines in Termination Deposits at Baking Pot

Although the causes are still debated, many archaeologists agree that the collapse (c. 750-1050 AD) of the Maya civilization was not caused by a single catastrophic event. Different regions and sites reacted to the "collapse" differently, but a common feature found throughout the Maya lowlands are terminal deposits--final assemblages of artifacts left during the Terminal Period that were found on floor surfaces and/or on the tops of ultimate buildings. The significance and meaning of terminal deposits in the Maya world continues to be debated by archaeologists, yet ceramic figurines present in these deposits has had little-to-no attention, specifically when it comes to a type of terminal deposits—termination deposits, or deposits of ritual material, such as ceramics and faunal remains, that were intentionally destroyed or "terminated" and disposed in specialized contexts. Due to their connection to ritual and reflection of household-state relations (Halperin, 2014), ceramic figurines have the potential to explicate termination activity and ritual and cultural changes during this period. The current study examines 105 ceramic figurines from the Belize Valley Archaeological Reconnaissance (BVAR) Figurine Project Database from sites B-17 and M410A located in Baking Pot. Figurines were coded according to their physical and content characteristics in order to identify patterns of form and any presence of ritual practice associated with termination. This project relieves that there is still much that can be learned from ceramic figurines in termination deposits.

Annie Haguma

University of Arizona

Tucson, Arizona

mentor: Cecilia Rosales, Celina Valencia

The On-going Issues of Vector Borne Disease in Mexico

Vector borne diseases are prevalent in the southern regions of Mexico. These regions include Chiapas and Oaxaca, which contribute to 90% of all Malaria cases in Mexico. According to the Pan American Health Organization (PAHO), Mexico contributes to 13.75% of all Chagas cases worldwide (Pan American Health Organization, 2012). The importance of studying vector borne disease in Mexico is the lack of research that has been done in the past years. Vector borne diseases in Mexico impact surrounding countries including Belize and Guatemala, which are high endemic countries. Travel between these countries help spread the infections. The economic state of these countries limits the medical attention of individuals with these diseases. In addition to this, more research in these diseases will help stop the spread of these disease. Furthermore, of the five vector borne disease (Chagas, Zika, Malaria, Dengue, and Chikungunya) prevalent in Mexico, only Malaria has a vaccine. Using data collected over the past decades from the PAHO, this study tracked the disease prevalence trajectory in Mexico. The results demonstrated that although there is a slight decrease in the rates of majority of the diseases, Chagas rates continues to increases drastically. Continuous awareness and additional research could potentially introduce new method and treatments to decrease the spread vector borne diseases.

Alexander Hartz

University of Arizona

Tucson, Arizona

mentor: Joseph Tolliver

The Definition of Hate Speech: An Analysis

Accusations of hate speech are increasingly more common in public life. However, hate speech is not a legally defined term in the United States. Because it is not legally defined, people lack the means to discuss and determine if given speech acts are hate speech. A philosophical definition of hate speech may be useful as a means for people to discuss and evaluate claims of hate speech. This research paper examines several theories of hate speech and oppression to determine if a definition of oppression can form the basis for a definition of hate speech. In order to achieve this aim, the paper first reviews several definitions of oppression to create a consolidated definition of oppression. The paper proceeds to analyze theories and examples of the harms of hate speech in relation to the consolidated definition of oppression. By evaluating theories and examples of the harms of hate speech in relation to a consolidated definition of oppression, the paper concludes that a definition of hate speech may be formed within the parameters of a definition of oppression. The definitions of hate speech and oppression supported by the paper are then defended against several objections. In conclusion, the paper recommends empirical research on the effectiveness of the definition of hate supported by this paper in discussions on hate speech as well as in the regulation of hate speech.

Alissa Hatfield

University of Arizona

Tucson, Arizona

mentor: Jean Marc Fellous

The Effects of Oxytocin and Arginine Vasopressin on Empathy in Rats

Recent studies have increased support for the presence of empathy, the capacity to share emotional states, in mammals besides humans. While much research has been done on empathy in humans, little is known about its neural mechanisms. Using a rat model in which animals show empathy-like behavior toward their conspecifics, we attempted to determine the influence of two substances known to be involved in social bonding, arginine vasopressin (AVP) and oxytocin (OXT). The experiment included intracerebroventricular injections of either the vehicle, AVP and OXT or the antagonists of AVP and OXT. Each injection was followed by a task in which the rat was trained to lever press in response to a visual cue in order to receive a food reward. The rat's preferred lever was paired with a footshock given to a familiar conspecific (cagemate). Manipulating the OXT system seemed to increase empathy by increasing the preference to the non-shock lever or by increasing the latency to the shock lever. Manipulating the AVP system with a highly selective antagonist to the V1a receptor decreased empathy and injecting AVP increased empathy. These results could be used to guide the treatment of disorders such as Autism Spectrum Disorder in which empathy is affected.

Katelyn Kennon

University of Arizona

Tucson, Arizona

mentor: Mary Koss

Is IX the loneliest number? - An inductive analysis of adversarial and restorative sanctions within four-year universities' student codes of conduct

The disruptive power of sexual assault proves especially potent in college campus communities. In addition to high prevalence among students, sexual assault perpetuates a climate of isolation and shame for survivors, peers, and perpetrators alike. Title IX and related legislation provide for a campus-based response to such a climate, often acted through punitive sanctions. However, in the literature, survivors desire sanctions more closely aligned with restorative justice principles. This research study is concerned with the range and tenor of sanctions available to student-survivors as enshrined in student codes of conduct, in order to determine whether student-survivors might find promise therein. A system of inductive coding was used to enumerate practical sanctions and to derive thematic groundworks from the codes of conduct of 50 four-year public and nonprofit private US universities. The results depict a randomly selected, stratified, and nationally representative sample with respect to region, size, control, and religious affiliation. Analysis indicates that while universities offer restorative sanctions, sexual misconduct is consistently rated as too serious for such arbitration. Therefore, many universities instead use exclusionary and shaming tactics and place emphasis on their status quos over student-survivors' agency. These findings illustrate the present atmosphere surrounding campus sexual assault. In administrators' haste to bolster their images against an onslaught of criticism, they have overcorrected their code of conduct sanctions, narrowing student-survivors' options to an unacceptable few. Hope remains, however, in the values-based missions of many universities, which prize personal growth and accountability in a manner similar to restorative justice.

Wing Pearl Lam

University of Arizona

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mentor: Ted Weinert

Gene Silencing in Budding Yeast

Gene silencing in budding yeast is a complex form of gene regulation known to participate in the aging process. While it is known that gene silencing at normally clustered DNA regions, including telomeres, ribosomal DNA, and the yeast mating locus, is integral to the aging process in budding yeast, this study explores a new gene silencing mechanism whose role in aging is still unknown. This study focuses primarily on constructing a possible gene silencing mechanism in relation to chromosome loss by mutating Sir2 and Mad2, highly conserved proteins responsible for gene silencing and regulating the spindle checkpoint, respectively. While this study has found that cells defective for the spindle checkpoint exhibit higher frequencies of chromosome loss, it has not yet determined whether the frequencies at which these cells exhibit gene silencing. We plan to continue this project into the fall, during which we would elucidate a mechanism by which gene silencing could occur in the context of chromosome loss and possibly, the aging process.

Kaitlin Libby

University of Arizona

Tucson, Arizona

mentor: Laura Lopez Hoffman

Habitat Distribution Model to Support Estimates of Wind Turbine Fatalities: A Case Study of the Mexican Free-Tailed Bat

In response to a call for robust research in turbine impacts on wildlife, this study presents a habitat distribution model predicting the occurrence of the Mexican free-tailed bat to be overlaid with current and proposed wind turbine locales. The model used, made through R with the package MaxLike, is applicable to other bat and bird species which are known to be impacted by wind turbines; the case of the Mexican free-tailed bat is a study testing the validity of the model and providing a lens to view wind turbines as one factor in the decline of a prominent, valuable bat species. Value is estimated economically through an ecosystems services approach. This study hopes to provide translatable research to a wide audience through the model's creation of several maps, which visually describe the relationship between Mexican free-tailed bat occurrence and the environment. That wide audience is to include the public, decision makers, and other institutions.

Nicole Lorona

University of Arizona

Tucson, Arizona

mentor: Cecilia Rosales

Obesity Prevalence Among Urban and Rural Populations in Sonora, Mexico

Obesity is a risk factor for cardiovascular disease, which is the leading cause of mortality in Mexico. Obesity prevalence has been increasing nationally, with the highest rates in the northern region where the border state of Sonora, Mexico, is located. This study uses data from the Mexican National Health and Nutrition Survey (Encuesta Nacional de Salud y Nutrición) to compare the prevalence of adult obesity in urban and rural contexts in Sonora, Mexico. The purpose of this research is to inform public health policy, programs, and science based interventions to curtail cardiovascular disease prevalence and incidence among Mexican populations. Trends from 2006 and 2012 data indicate a higher prevalence of obesity in urban areas in comparison to rural areas, a higher prevalence of obesity among urban and rural women than men, and a larger disparity in prevalence between urban and rural men than between women in both contexts. While these findings show differences in obesity prevalence between urban and rural contexts, further research is needed to better understand the differences in obesity observed among men and women in Sonora, Mexico.

Megan McHugh

University of Arizona

Tucson, Arizona

mentor: Cho Lik Chan, Celina Valencia

Energy-Conversion Technology: Optimization of the Stirling Engine

This paper provides a study on the configuration of Stirling engines and the effect on the efficiency, which was measured by the power output. The base model used was a Gamma configuration, low temperature differential Stirling engine. Temperature and speed were measured for the base model Stirling engine to determine the initial efficiency. Modifications were planned to change the amount of dead volume in the design to determine what amount of dead volume would optimize the efficiency of the engine. The work performed by the engine was to be calculated using the Schmidt formula to then find the power output. Results from the completion of this study would indicate that how increasing or decreasing the dead volume would influence the power output of the Stirling engine.

Maegan Morrow

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Tucson, Arizona

mentor: Melissa Barnett

Social Media and its Associations with Self-Esteem in Young-Adult Females

The present study examined the possible associations between the use of social media and self-esteem in young-adults females. In the last decade social media has become a dominating presence in everyday life, with most adolescents and young-adults belonging to one or multiple social media platforms. Although there have been studies on the impact of family, peers, and media on self-esteem in young-adult females, there has been relatively little research on the possible associations social media use could have with self-esteem. I hypothesized that more frequent social media use would be negatively correlated with self-esteem. The Rosenburg Self-Esteem Scale, Luhtanen and Crocker's Collective Self-Esteem Scale, and items measuring the frequency, rate, and intensity of social media use were utilized in a short anonymous survey sent to a sample of young-adult females ages 18-22 (N=62). A significant negative correlation was found between self-esteem and intensity of social media use ($r=-.44$, $p<.01$). These findings are consistent with the hypothesis that more time spent using social media is associated with lower self-esteem in young-adult females.

Jasmine Raysor

University of Arizona

Tucson, Arizona

mentor: Connie Beck

Disparities in Violence Among Different Ethnic Groups in the Involuntary Civil Commitment Process

Although black people constitute roughly only 13% of the population in the United States, they account for approximately 40% of the national prison population. Their Caucasian counterparts, on the other hand, who are 64% of the overall U.S. population, compose 40% of the prison population, meaning that Blacks are almost five times more likely to be incarcerated than Caucasians (Carson, 2014). This statistic is often cited to suggest that Blacks are more likely to commit crimes and that they may have a "culture of violence," (Farbota, 2015). The present study seeks to focus on the relationship between ethnic differences and violence specifically in those who have legal involvement due to mental health reasons. This study examines the trends in the types of violence allegedly present in members of different ethnic groups petitioned into the Involuntary Civil Commitment process. Participants in this study were a random sample (N=100) of those petitioned for the first time in Pima County, Arizona in 2006 (N=1106). The legal documents associated with Applications for Emergency Admission for Evaluation were de-identified, double-coded, entered into a spreadsheet, and were analyzed by a team of research assistants and a principal investigator to determine frequencies of and differences among ethnic groups in alleged actual and ideated violence. The implications of the results of this study could prove to be very useful in tailoring court-ordered treatment towards unique individuals and ensuring that those with mental illnesses receive proper treatment.

Ivan Rodriguez

University of Arizona

Tucson, Arizona

mentor: Joseph Watkins

Ameliorating Statistical Methodologies as Genomic Data Burgeon: Refined Proportional Odds Model with Application to New Dravet Dataset

Approximately 150,000 newborns are diagnosed with a genetic disease each year. Due to the exponentially growing wealth of genomic data, genetic background information can more readily be related to these various medical conditions. Physicians address the needs of these children using an assortment of diagnosis instruments, reporting a ranked classification of the patients' condition. New statistical methodologies are called upon to comprehensively analyze the genomic statistics and the doctors' assessments. This study seeks to match data and diagnosis by improving upon the celebrated proportional odds model (POM). The simulation studies herein assess the proposed model's statistical power and its response to varying sample and effect sizes. Additionally, an application to a new and exclusive dataset is provided that relates Dravet syndrome patients and a selection of candidate genes. One preliminary finding is that rare phenotypes are more prevalent for young Dravet patients with a severe diagnosis; moreover, both common and rare phenotypes provide clues that several genes may play a role in protecting or exacerbating Dravet, likely on a case-by-case basis. By modifying and appending to the POM, these links have been found to be both multifaceted yet comprehensible and contingent on sample heterogeneity. These results demonstrate that severe genetic conditions may have modifying genes that strongly influence quality-of-life. Although medication and treatment may presently exist, the identification of these modifying genes can provide impetus for the development of new drugs and approaches. As genomic databases continue to grow, this process will aptly become more commonplace.

Raymond Rosas

University of Arizona

Tucson, Arizona

Mentor: Stephanie Troutman

Alternative Pedagogy as Praxis: Evaluating Teachers' Perceptions

Traditional English writing pedagogies are solely concerned with teaching the fundamentals of writing and English composition. Moreover, current research (Thomas, 2015; Borsheim-Black, 2015; Legg, 2014) has shown that dominant pedagogical discourses usually benefit one group of writers (those who are proficient in the dominant discourse), while marginalizing others (those who are non-proficient). Historically, minority students score lower than their white counterparts on state standardized tests in the categories of reading and writing. Alternative pedagogies (anti-racist pedagogy, critical pedagogy, etc.) have been shown to increase achievement levels of minority students by accounting for factors that traditional pedagogies ignore. More research, however, is needed to discover the best methods for the implementation of theses alternative models of instruction on a wider scale. The purpose of the current research is two-fold: (a) analyze teachers' attitudes towards and values about the use of alternative pedagogies, and (b) discover any institutional impediments regarding the use of alternative pedagogical models. Qualitative analysis in the form of semi-structured interviews will be used to ascertain teachers' perspectives about and experiences with the aforementioned issues. Four English teachers participating in a professional development program at a major Southwestern university will be invited to participate in the study. Initial, axial, and selective coding will be used for data analysis and interpretation. Final data collection and analyses will occur in Fall 2016.

Bailey Tibben

University of Arizona

Tucson, Arizona

mentor: Ross Buchan

Implications of Cdc48 in Stress Granule Clearance and Autophagy

This study seeks to elucidate the mechanism by which the motor enzyme Cdc48 contributes to stress granule clearance in an autophagic manner. In this study, Saccharomyces cerevisiae (brewer's yeast) is used as a model organism in which several Cdc48 mutations are introduced and the effects examined. Specifically, mutant Cdc48 strains are compared with the wild type (WT) via growth assays to assess how Cdc48 mutations influence overall cell growth and survival. Furthermore, fluorescence microscopy is utilized to determine what domains and/or functions of Cdc48 influence the accumulation and clearance of stress granules under varying stress conditions, as assessed by Pab1-GFP levels and localization. Interestingly, mutations in the N-terminal domain of Cdc48 result in cells that are sensitive to sodium azide stress conditions in which growth is significantly reduced, specifically Cdc48 mutant R165H. Furthermore, other N-terminal domain mutations make cells more prone to the accumulation of stress granules in the cytosol as compared to the wild type. Finally, mutations in the D1 AAA+ domain (K261A) of Cdc48 result in less stress granule accumulation and an increased number of P-bodies compared to the wild type. Based on these findings it appears that the N-terminal domain of Cdc48 is important for turnover of Pab1, stress granules, or both, while the D1 domain may play a role in P-body to stress granule transition.

Biosphere 2: Research Experience for Undergraduates

Program Director: Katerina Dontsova, PhD

UA's Biosphere 2 facility is the site of this NSF funded Research Experiences for Un- dergraduates summer research experiences. By using a multidisciplinary approach (involving disciplines such as hydrology, geology, geochemistry, ecology, biology, physics, engineering, and atmospheric sciences) research teams focus on under- standing how earth systems respond to environmental change. Open to freshmen, sophomores, and juniors.

Alec Fojtik

Wheaton College

Wheaton, Illinois

mentor: dr. Dave Breshears, Mallory Barnes

Water Stress Reduces Evaporative Cooling in Hybrid Poplars during Hot Drought: Genotype Influences Degree of Coupling between Thermal Stress and Atmosphere

Climate change is projected to increase the frequency and severity of drought in many regions worldwide. Predicted global temperature increases are expected to exacerbate drought impacts on ecosystems, with dramatic consequences including widespread forest mortality and ecosystem reorganization. Of particular concern is the response of woody plants, especially those which are commercially significant, to drought during hotter temperatures. Quantifying the physiological effects of hotter drought on woody plants can improve understanding of their limitations in scenarios of prolonged increased temperatures (associated with climate change) and their adaptability to future conditions. Here we document an association between water stress and thermal stress in two genotypes of hybrid poplar trees during a naturally occurring hot drought in Southern Arizona. Genotype 57-276 had small, diamond-shaped leaves, while genotype R-270 had large, rounded leaves. Pre-dawn water potential was compared to the difference between leaf temperature and air temperature (ΔT), and meteorological variables including vapor pressure deficit (VPD), photosynthetically active radiation (PAR), and wind speed as the drought progressed. In both genotypes, pre-dawn water potential was negatively related to ΔT when leaf temperature was higher than air temperature. Leaves from highly stressed plants were the hottest compared to ambient air temperature. This suggests that water stress results in a reduction in leaf transpiration and associated evaporative cooling. Each genotype also had unique factors affecting ΔT. The genotype with small leaves was more tightly coupled to the atmosphere, with ΔT influenced by PAR, and wind speed. This is consistent with smaller, diamond-shaped leaves, which results in a smaller leaf boundary layer that is more sensitive to atmospheric conditions. For the larger genotype, ΔT weakly related to PAR, but none of the other atmospheric factors. The observed relationship between thermal and water stress in both genotypes suggests reductions in evaporative cooling during hot drought. Genotype-specific relationships between thermal stress and the atmosphere indicate morphological influences on plant response to drought.

Amanda Kerr

Northeastern University

Boston, Massachusetts

mentor: dr. Craig Rasmussen, Christopher Shepard

Linking Soil Chronosequence Properties to Landscape Evolution in Southern Arizona

Soil chronosequences quantify changes in soil chemical and physical properties over time and are useful for understanding local, spatial and temporal patterns in soil-landscape evolution. Few past chronosequence studies explore specific relationships between iron content and Aridisols of the Southwestern United States in the context of glacial-interglacial cycling. Here we focus on a series of alluvial fans located on the northeastern flank of the Pinaleño Mountains near Safford, AZ. The alluvial surfaces ranged in age from late Pliocene to late Pleistocene. Color, pH, electrical conductivity (EC), and loss on ignition (LOI) were measured to understand changes in soil properties with time. We found depth weighted average redness rating (RR) increased linearly with time from youngest to oldest surfaces (r^2 = 0.64), which suggests increased hematite content with age. Further, depth weighted average pH KCl decreased logarithmically over time (r^2= 0.81), indicative of increased chemical weathering. Depth weighted LOI and depth weighted RR showed a strong linear correlation (r^2= 0.82), which is indicative of the adsorption of organic matter onto iron-oxide surfaces over time. With further analyses, we expect to find that pedogenic iron concentration increases with time, and thus functions as a suitable proxy for soil age and degree of soil development. These results show that soil chronosequences serve as acceptable models for understanding local, geomorphologic and climatic fluxes, and may enable interpretation of the influence of past climate change on soil formation and survival.

Anthony J.G. Tornito

University of Guam

Mangilao, Guam

mentor: dr. Joost Van Haren

Understanding Changes of Stomatal Conductance under Different Atmospheric Humidity Levels for Different Tropical Rainforest Species in Biosphere 2

Understanding the dynamics of climate change is one of the biggest questions that scientists across the globe ask today. With understanding climate change comes the need to understand the ecological systems and how their biological and chemical processes contribute to climate change. Tropical rainforests are very productive systems and are responsible for most of the world's carbon budget. To maintain cooler conditions, tropical forests mitigate warming through evapotranspiration. Transpiration is an important mechanism that a plant undergoes. At the leaf level, stomates regulate CO_2 intake and H_2O output, which is ultimately limited by climate conditions such as availability of carbon, water, and light. The purpose of this project was to measure short-term plasticity by looking at stomatal conductance levels of different tropical rainforest plant species in the rainforest, savannah, and desert biomes in the Biosphere 2 facility in Oracle, Arizona. It has been observed that temperature levels may not affect stomatal conductance because of the variability associated with it; however, little is known about the effects of humidity on stomatal conductance.

Results indicated that there was a potential trend amongst these rainforest species when placed in different humidity percentage areas. By understanding stomatal conductance in response to humidity, we can better understand how productive rainforest systems are when humidity levels decrease, which may potentially occur as Earth undergoes global climate change.

Carol Morel

Wofford College

Spartanburg, South Carolina

Mentor: Jennifer McIntosh, Rachel Tucci

Modeled Impacts of Sulfuric Acid Leaching Solution on Two Groundwater Populations in the Cienega Creek Watershed

The impact of heap leaching on groundwater chemistry quality is imperative to analyze model whenever such a process is proposed under a mine plan of operations. Untreated seepage of heap leach solutions can lead to plumes of sulfate and dissolved metals that have the potential to contaminate potable groundwater. In the Santa Rita Mountains, located in the Cienega Creek Watershed (CCW) 30 miles southeast of Tucson, Arizona, a mine plan of operations has been submitted in which the proposed action plan involves sulfuric acid heap leaching for oxide ore processing. Previous models predict a total 168 million gallons of seepage from the heap leach pad over a period of 115 years, at which point the seepage is expected to cease. These models also reveal that if left untreated, the leach solution does not meet maximum contaminant and secondary contaminant levels for pH, sulfate, and dissolved metals. The objective of this study is to determine the chemical characteristics of the CCW groundwater when mixed with various concentrations of leach solution in order to determine at what proportion of seepage do pH, sulfate, and dissolved metals exceed Federal maximum contaminant levels (MCL). Existing data was compiled on the CCW groundwater and two populations were found, one dominated by CaSO4 and the other by CaHCO3. Both waters have samples that preemptively exceed MCL for Al, As, Fe and Pb. The CaSO4 groundwater also had high SO4 and Mn levels. PHREEQC was used to model potential mixing of the pregnant leach solution with the two disparate groundwater populations at proportions ranging from 0.1:99.9 to 99:1. Our models also simulated percolation through a calcite-containing aquifer to better simulate natural conditions. The results indicate that the calcite acts as a suitable buffer for the pH of both groundwater populations; however, it does not mitigate the augment of sulfate in either groundwater type. Both groundwater types saw increases in Be, Cd, Cu and Se past MCLs. The CaHCO3 groundwater had an additional increase in Mn past MCLs. This study is able to provide a better understanding of the potential, unmitigated impacts of heap leach mining in the Cienega Creek Watershed.

Taylor Gray

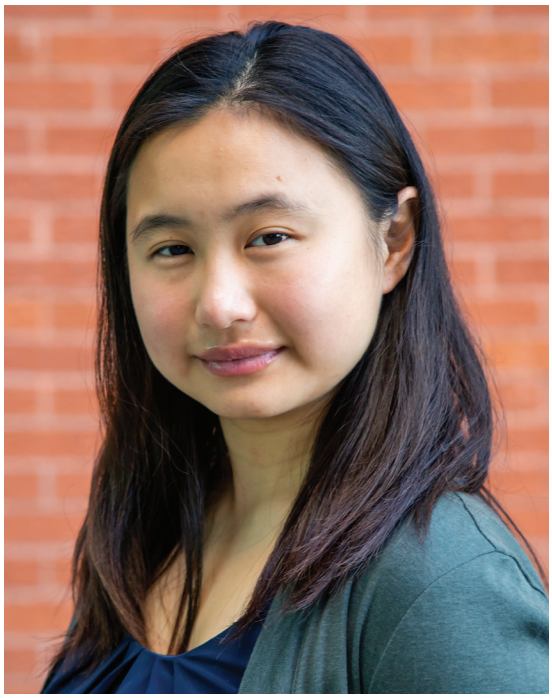
Ohio State University

Columbus, Ohio

Mentor: Dr. Peter Troch

The Use of Stable Isoptope Tracers to Quantify the Transit Time Distribution of Water

To improve water quality, scientists must develop land management methods that can avoid or mitigate environmental pollution. State of the art tools to develop such methods are flow and transport models that trace water and other solutes through the landscape. These models deliver important information that can lead to remediation efforts, improving the quality of water for humans, plants, and animals. However, these models may be difficult to apply since many details about the catchment may not be available. Instead, a lumped approach is often used to attain the water transit time using stable isotope tracers such as ^{18}O and ^{2}H that are naturally applied by precipitation to a catchment. The transit time distribution of water is an important indicator for the amount of solutes soil water and groundwater can contain, and thus can predict water quality. We conducted a 2-week long experiment using a tilted weighing lysimeter at Biosphere 2 to observe the breakthrough curves of deuterium and artificial DNA. We show that hydrological parameters can be used to estimate the transit time distribution of deuterium. The convolution integral is then used to determine the distribution of the water transit time in the system. Unfortunately, stable isotopes make it difficult to pinpoint a specific flowpath since they naturally occur in the environment. Recent studies have shown that DNA tracers are able to trace water through the landscape. We found that DNA has a similar breakthrough curve happening at similar timescales as deuterium. Therefore, DNA tracers may be able identify sources of nonpoint source pollution in the future.



Madeline Widjaja

Sweet Briar College

Sweet Briar, Virginia

MENTOR: DR. PETER TROCH, DR. TILL VOLKMANN

Stable Isotope Laser Spectrometer Comparative Study through Vapor Concentration Manipulation

Stable isotope analysis allows us to trace elements through meteorological, geological, and vegetation systems. The increased study of laser absorption analyzers, over previously used accelerator mass spectrometers, is making highly precise, near real-time, monitoring of natural systems feasible. An important requirement for the interpretation of data from automated long-term field measurements is a detailed knowledge of instrument characteristics and the ability to properly calibrate the instruments. Here, we performed a comparative study between two types of laser spectrometers using a new low-cost, high-flow calibration system. The instruments included a tunable diode quantum cascade laser spectrometer and an off-axis integrated cavity output spectrometer. The calibration system was tested for its ability to provide a stable, but adjustable, delivery of vapor from liquid samples of varied standard sources. Water vapor from the system was simultaneously ran through both spectrometers for a real-time comparison of the lasers' δD (deuterium) and δ18O values. Variability was created by changing the vapor moisture content though adjustments of the system's sample flow rate. The collected data was analyzed to compare the lasers' measurement stability, precision, and vapor concentration dependency. These results show that the tested laser spectrometers and calibration system set up has promising reliability and stability, which can open up experiments to a wider range of researchers who require a less expensive and/or continuous high-flow method of isotopic vapor analysis.

Marcella Meza

Luther College

Decorah, Iowa

mentor: dr. Peter Troch, dr. Aditi Sengupta

Analysis of Microbial Dynamics in miniLEO Soil

Soil microorganisms play a crucial role in our biosphere. Soil microbial dynamics affects processes such as nutrient cycling, rock weathering, soil formation, and terrestrial gas fluxes. Biosphere 2 (B2) presents an opportunity to study diverse soil microbial communities present in different environments under one glass roof. This study is the first to focus on microbial characterization in Biosphere 2. The project emphasis was to examine soil microbial diversity in the miniLEO hill slope (a small version of the LEO hill slopes).

The objective of this study was to analyze microbial community sequence data of miniLEO soil samples. Samples are representative of length, depth, and width profile of the miniLEO. Sequence data was made available through Illumina Mi-Seq platform. Sequences were analyzed to identify community patterns, and classify groups of microbes and their metabolic functions. Despite being highly oligotrophic, the system was rich in species diversity. Numerous phyla were identified, the five most abundant being: Verrucomicrobia, Actinobacteria, Planctomycetes, Proteobacteria, and Euryarchaeota. The surface layer had the most distinctly different distribution of communities compared to all of the other depths. Metabolically heterogeneous groups were found with respect to depth. This preliminary analysis provides key clues to understanding the presence and effect of microbes in miniLEO soil. The results will be applied to studying microbial community development over time and space in miniLEO and inform microbial sampling decisions on LEO.

Moises Umanzor

University of Maryland

College Park, Maryland

mentor: dr. Katerina Dontsova, Yadi Wang

The Role of Geochemical Weathering during Incipient Soil Genesis

Studying co-evolution of hydrological and biogeochemical processes at the subsurface of natural landscapes can enhance the understanding of coupled Earth-System processes. Such knowledge is imperative for improving predictions of hydro-biogeochemical cycles, especially under climate change scenarios. At Biosphere 2, the Landscape Evolutionary Observatory (LEO), a model watershed, was designed to identify landscape evolution patterns arising from cumulative heterogeneous hydrological, geochemical, and microbiological processes.

Mini-LEO, a 2 meter in length, 0.5 meter in width and 1 meter in depth sloped weighing lysimeter, was designed and implemented to evaluate possible experimental schemes prior to examination on the full scale LEO slopes. Mini-LEO was filled with crushed granular basalt rock with a known initial composition. After 18 months of intensive hydrological study, the landscape was divided into 324 soil voxels and excavated. Collected samples were subjected to detailed hydro-bio-geochemical analysis.

A five-step sequential extraction was chosen to characterize incongruent mineral weathering, dissolution of primary minerals and precipitation of secondary minerals, and, soil formation on the mini-LEO slope. Change in Fe and Mn concentrations along mini-LEO length and depth for each step of the sequential extraction was measured to characterize spatial distribution of weathering processes on the slope. The results cannot only help understand basalt weathering as a function of rainfall and position on the slope, but also, coupled with information about microbial community composition, to understand the effect of coevolution of biological and abiotic components of the slope on soil formation.

Rebecca Hingley

Juniata College

Huntingdon, Pennsylvania

mentor: Katerina Dontsova

Effects of Climate Change and Vegetation Type on Carbon and Nitrogen Accumulation during Incipient Soil Formation

Plants play an important role in carbon and nitrogen fluxes in the environment. Photosynthesis is an important mechanism of carbon removal from the atmosphere while root exudation or root senescence contributes to soil formation and the accumulation of carbon in the soil. Additionally, plants can also facilitate sequestration of CO_2 from the atmosphere in the form of inorganic carbonates during the process of mineral weathering. With increasing temperatures and levels of CO_2 in the atmosphere, it is unknown what effect these changes will have on plant growth and weathering of silicate rocks, and by extension on carbon accumulation in the soils. To identify these effects, a controlled study was conducted at Ecotron Ile-de-France utilizing mesocosms at elevated and ambient CO_2 concentration and temperature with four different vegetation treatments: control, alfalfa, mesquite, and sprangletop. At the end of this study, soil samples were taken from each mesocosm at four different depths and then analyzed for organic carbon, inorganic carbon, and total nitrogen, since nitrogen availability can be a limiting factor on carbon sequestration. Accumulation of organic and inorganic carbon and nitrogen, particularly in the two top layers, was observed in all mesocosms. Mesocosms with elevated carbon dioxide concentrations had a trend towards higher inorganic carbon concentrations but lower organic carbon concentrations. In addition, plants capable of nitrogen fixation tended to have higher concentrations of nitrogen and organic carbon in the soil, but had lower inorganic carbon concentrations. This suggests that climate change can impact carbon and nitrogen accumulation in soils.

Sarah Cheung

Pasadena City College

Pasadena, California

Mentor: Dr. Joost van Haren

Acclimation of Leaf Photosynthesis in Tropical Plant Species of Biosphere 2 to Changing Conditions over the Past Two Decades

Tropical rainforests encompass diverse ecosystems and play an important role in both the global carbon and water cycles. Despite their significance, they remain poorly characterized compared to other biomes on the planet. Central to this shortcoming is the limited information available regarding photosynthesis in tropical plant species. In this research project, we took advantage of the large and controlled system of the rainforest mesocosm of Biosphere 2 to further our understanding of tropical species. We studied how leaf photosynthesis in six different canopy species acclimated to the current conditions (e.g. higher temperature and lower CO_2 concentration) in Biosphere 2 by comparing results with those dating back to 2000. The photosynthetically active radiation (PAR) curve measurements indicated a much higher light response for the canopy plants in 2016 than in the study (Adams 2004) conducted in the early 2000s. However, the net CO_2 assimilation rate versus calculated substomatal CO_2 concentration (A-Ci) curve measurements revealed a decrease in CO_2 response in the plants. Our results suggested that the trees have adapted to greater light levels and higher temperature conditions as they grew in height with maturation. In contrast, the plants have reacclimated to lower levels of CO_2 concentration since the time people lived inside Biosphere 2.

Electrical and Computer Engineering Cognitive and Autonomous Test Vehicle

Program Co-Director: Jonathan Sprinkle, PhD

Program Coordinator: Nancy Emptage

The CAT Vehicle research experience for undergraduates (REU) is engaged in the myriad of ap- plications that are related to autonomous ground vehicles. Each summer, NSF-fund- ed undergraduate students participate in an immersive research experience, sitting side-by-side with graduate researchers and working on one of the most compelling, and complex, applications of today: autonomous systems.

Anthoney Arkadie

Western State Colorado University

Gunnison, Colorado

mentor: Hamed Asadi, dr. Jonathan Sprinkle

DSRC Security using Radio and On-Board Sensors

Partner: Bryan Wieger

Vehicular Ad Hoc Networks (VANETs) are subject to many security challenges due to the decentralized and dynamic nature of such networks. One such challenge lies in verifying the telemetry and identity of a vehicle in both the local and global perspective of the network.

This paper investigates the use of Phase Difference of Arrival to estimate the Angle of Arrival as well as using the Received Signal Strength to approximate the location of the transmitting vehicle. This information is then cross-checked with the data from the onboard sensors and the data of the transmitted data. The data from the onboard sensors, in our case a 2-D LiDAR scan, is processed through an object identification algorithm. When any of the three sets of data do not match, we consider that the vehicle may not be trustworthy.

The level of trust assessed to a transmitting vehicle is dependent on which set of data does not correspond to the communicated telemetry. If neither the radio properties or the LiDAR data match the transmitted message, we consider the transmitter as untrustworthy. The same is true if it is just the LiDAR data that does not match. If only the radio properties do not match the transmitted message, the transmitter is flagged as undetermined. If both LiDAR and radio properties match the transmitted data, the transmitter is considered trustworthy. These classifications are influenced by the high dynamic nature of channel properties and that LiDAR data is reasonably reliable.

Anu Deodhar

University of Oregon

Eugene, Oregon

mentor: dr. Jonathan Sprinkle, Matthew Bunting

Constraint-Based Modeling and Safety Verification of Autonomous Vehicle Trajectories

Partner: Swati Munjal

In order to operate an autonomous vehicle, a user must have considerable knowledge and experience in low-level programming. This research involves the development of a domain-specific modeling language that allows the user to send commands to an autonomous vehicle without previous programming knowledge. A modeling language was designed with inspiration from a state machine, where a user can enter motions of the vehicle as directions, or states, in combination with transitions, or conditions to propel a change between the states. This visual modeling language was developed with WebGME, with an emphasis on safety verification tools for design-time and runtime operations. The language implements sensor configuration for reactive behaviours by avoiding obstacles during runtime. Once the user has created a model, verification methods using Simultaneous Localization and Roadmapping (SLAM) was used to ensure that dynamic constraints were met before generating artifacts. Subsequently, probabilistic roadmap planning (PRM) strategies were used to see if the proposed trajectory was valid for the given map. Verification tools, error checking, and meta modeling were used to establish a visual modeling language of an autonomous vehicle. From this modeling language, the user will be able to detect if the inputted path was valid in terms of the path collision with obstacles.

Nathaniel Hamilton

Lipscomb University

Nashville, Tennessee

MENTOR: DR. JONATHAN SPRINKLE, KUMAR BHADANI

Velocity-Based, Car-Following Controller Intended For Use In Stop-And-Go Traffic Situations To Damp Traffic Waves

Partner: R'mani Haulcy

Adaptive Cruise Control (ACC) and Traffic Aware Cruise Control (TACC) are more recent improvements in the cruise control design that allow a semi-autonomous vehicle to slow itself when approaching vehicles. The issue with these technologies is that they focus on keeping the distance from a leading vehicle constant. This often leads to unwanted dynamics in the following traffic flow, which results in the creation of traveling waves. This paper focuses on maintaining a reference velocity based on the relative position of the preceding vehicle instead of slowing down to maintain a certain following distance. Doing so will reduce the amount of braking the vehicles behind the autonomous vehicle will do. With this kind of technology implemented, the number and duration of traffic jams could be greatly reduced. Simulation results and tests run on the ByWire XGV autonomous vehicle illustrate the feasibility and success of this new controller.

R'mani Haulcy

Yale University

New Haven, Connecticut

Mentor: Dr. Jonathan Sprinkle, Rahul Kumar Bhadani

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Partner: Nathaniel Hamilton

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Swati Munjal

University of Arizona

Tucson, Arizona

mentor: dr. Jonathan Sprinkle, Matthew Bunting

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Partner: Anu Deodhar

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Emily Sheetz

Monmouth College

Monmouth, Illinois

mentor: dr. Jonathan Sprinkle, Nathalie Risso

System Identification Design of a Hybrid Model for an Autonomous Vehicle

Partner: Timothy Tadros

An important part of building an autonomous mobile control system is creating a model that accurately reflects the system's behavior in order to predict and plan the future state of the system. Several approaches to building a model of an autonomous vehicle have been implemented and studied. However, the trade-off between the accuracy and computation time of a model makes it difficult for an autonomous system to use accurate models in real-time to plan its trajectory. In the research presented in this paper, we use system identification to develop a model that accurately predicts the trajectory of the vehicle while reducing the computation time of the model. This model is built from experimental data collected from the CAT Vehicle at the University of Arizona. Our model is implemented on a hybrid predictive controller and tested in simulations and real-world applications. The controller uses the model to follow a planned trajectory and avoid obstacles in the state space with reasonable computation time. While the proposed model is specific to a particular autonomous vehicle, our methods and models could be applied to other autonomous systems.

Carrie Smith

Seattle University

Seattle, Washington

MENTOR: DR. JONATHAN SPRINKLE, HAMED ASADI

Intelligent Functionality Manipulation Mechanism for Automotive Radars

Partner: Tyler Sypherd

This paper addresses our expectation that millimeter wave automotive radar will create undesirable interference with sensitive radar enabled facilities such as radio astronomy telescopes and military centers. Using several methods, we derived general usage zones of the automotive radar that illustrate certain actions that need to be taken by the vehicular system in order to protect the integrity of a millimeter wave enabled facility. Thus, we propose a solution considering geographical surroundings and atmospheric conditions, in which we propose that control of the output power of the transmitting antenna of the radar is adjusted based on such predefined zones.

Tyler Sypherd

Arizona State University

Tempe, Arizona

mentor: Hamed Asadi, dr. Jonathan Sprinkle

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Timothy Tadros

Dartmouth College

Hanover, New Hampshire

mentor: dr. Jonathan Sprinkle, Nathalie Risso

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Partner: Emily Sheetz

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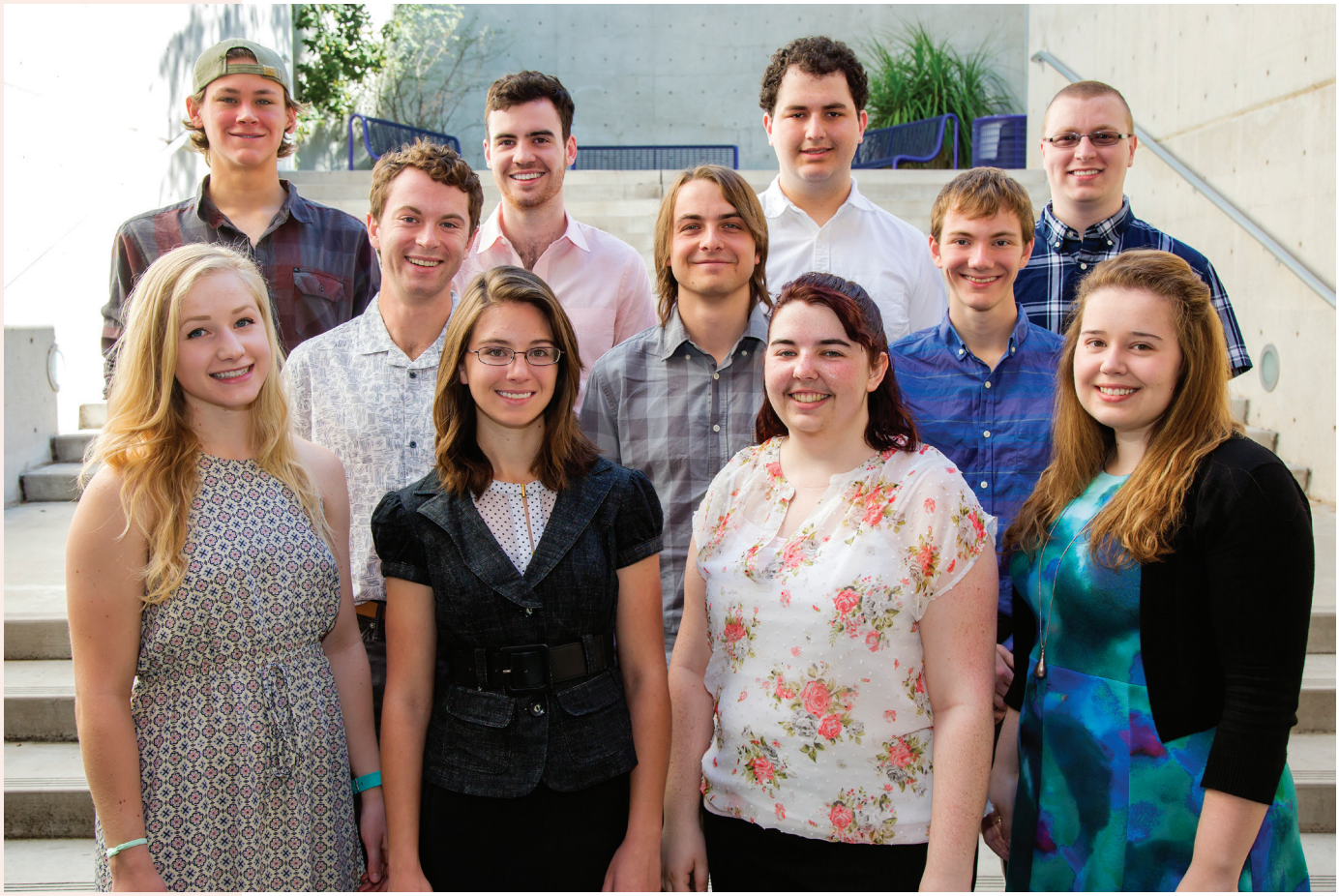
Research in Optics (RIO)

PI: R. John Koshel, PhD.

Coordinator: Melissa Sarmiento Ayala



The UA College of Optical Sciences is internationally recognized for its innovative research programs. Our research covers a broad set of technologies and techniques for using the properties and applications of light, touching virtually every eld of science and industry. Our faculty are innovative and decorated — and constantly expanding the boundaries of optics knowledge. This program is geared toward students in STEM elds and open to rising juniors and seniors or second year com- munity college students.

Cameron Chaves

University of San Francisco

San Francisco, California

MENTOR: Jerome Moloney

Influence of Dislocations on Optically Pumped VECSELs

Semiconductor chips are used in the construction of lasers due the fact that they are easily tunable, have a high power output, and produce a wide bandwidth. These chips are manufactured by layering AlAs, GaAs, InGaAs and GaAsP to create a Bragg reflector, quantum wells and barriers respectively. Differences in lattice constants among adjacent layers applies a stress to the chip, which may lead to dislocations. These dislocations, if present in the cavity mode, adversely affect laser quality. To quantify these effects, an ultrafast probe laser incident on a VECSEL chip is used to excite the carriers at 80MHz; photoluminescence from the decay is recorded for sites which contain dislocations and those that do not. Results indicate there is a nontrivial shortening of carrier lifetime due to pumping on dislocations. Resonant periodic gain structures, structures which have a single quantum well placed at each antinode of the standing wave to maximize field enhancement, exhibited an upper-state lifetime near a dislocation that was 21.5% less than that of carriers on a clean pump location. Multiple quantum well structures, which broaden bandwidth by placing two wells off center from each antinode, show a decrease of 16.7% and 9.2% for separate chips. Gain at pump location permitting, a power curve of the laser was recorded; threshold pump power for a clean pump location on an RPG structure was 4W compared to a threshold of 5W for a dislocation.

Luke Ender

Whitworth University

Spokane, Oregon

mentor: Yuzuru Takashima

3-D Interactive Visualization Platform for Ray Aberration Generator

The Ray Aberration Generator (RAG) developed by the Takashima Lab is an excellent tool for teaching students how real-world ray aberrations manifest, enabling them to more fully understand optical systems and correctly identify and treat aberrations. However, the entire RAG is far too bulky to be mobilized, limiting its teaching potential as a pedagogical device to only those on-site. To resolve this limitation, a remote viewing system was created which does not sacrifice either the 3-D visualization or the spatial interactivity of the RAG. The system was developed for the Google Cardboard platform, utilizing a uFactory uArm robotic arm and two HD webcams such that students anywhere in the world with access to an Android cellphone with a gyroscope and an internet connection can view a live 3-D video and spatially interact with the system.

Nicolette Fudala

Loyola University, in Chicago

Chicago, Illinois

MENTOR: DR. LEE JOHNSON

3D Printed Interferometer Design and Affordable DOEs for Optical Demonstration

While laboratory and industrial quality interferometers and diffractive optical elements (DOEs) are available for very precise application, costs reach $5,000 and upward. There is a lack of devices suitable in quality, portability, and flexibility for demonstration and educational purposes at the mid-to-low price range.

To address the need for affordable, yet effective parts in interferometry, new models were designed in Solidworks and manufactured using 3D printing. Interferometer parts were designed to be compatible with a previous Physical Optics Demonstration Bench made to exhibit diffraction, interference, and coherence effects. Based on the Michelson interferometer, the system was constructed from simple ABS piping, 3D printed modules, and other low cost optical elements. Of the 3D printing methods explored, selective laser sintering (SLS) delivered the best quality while keeping overall cost under $500.

Additionally, various methods for manufacturing DOEs were investigated. While high-end DOEs are typically created using a custom direct write lithography tool, such as the Maskless Lithography Tool (MLT) at the University of Arizona, these are largely unavailable. To make DOEs available for educational purposes, several low- and mid-cost fabrication methods were investigated. Low-cost methods included transparency prints, paint-on-glass etching, punctured HDPE plastic on glass, and burning through papers and plastics. Mid-range options involved third party laser etching or lithography mask shops.

Because of the high demand for these products in education, a website or blog with component lists, design instructions, STL files, and experiments will serve as outreach to the public.

Jacob Guttman

Rose-Hulman Institute of Technology

Terre Haute, Indiana

mentor: dr. Dae Wook Kim, student mentor: Isaac Trumper

Point Cloud Stitching and Mid-Spatial Frequency Error Control

Modern optical fabrication techniques often result in mid-spatial frequency errors, which can be harder to detect and address than other surface errors. One way to detect these errors is by creating a point cloud of depth/height data of an optical surface. However, many modern optics are too large for modern 3D imaging devices to generate sufficiently high resolution point clouds of the entire surface. Therefore, it is necessary to take point cloud images of smaller areas across the surface and stitch these point clouds together to create a high resolution point cloud across the entire optical surface. We investigated methods of stitching together point clouds gathered using the Microsoft Kinect sensor. The goal of this work is to better understand the available methods for addressing this problem and working toward a high-resolution imaging process to detect mid-spatial frequency errors. During this process, a preliminary method for stitching was developed using a version of the iterative closest point algorithm. This method is shown to be better at given tasks than some previously used methods, but is not ideal, and the investigation performed helps to identify areas that require future development and gives a look into possible future implementations.

Hannah Knaack

Harvey Mudd College

Claremont, California

mentor: Poul Jessen

Analog Quantum Simulation of a Quantum Kicked Top

An analog quantum simulator (AQS) is a highly controllable quantum system whose evolution is manipulated to simulate the behavior of a different quantum system. AQS has been proposed as a way of studying quantum systems too complex to model with classical computers. However, unlike in a computer simulation, we have no framework to understand how experimental errors and imperfections could affect our results. With this work we hope to address a key question: what, if any, parts of an AQS can we trust? To this end, we used an ensemble of ultracold cesium atoms as AQSs to simulate a well-understood model of both classical and quantum chaos: the kicked top. Simulating a chaotic system is interesting because it is hypersensitive to errors and thus cannot be reliably tracked by an AQS. Instead, we looked for global features in our simulation that might be reliably captured even if the exact quantum state is not. One such feature might be the boundary between stable and chaotic regions of the kicked top's evolution. We first studied the eigenstates of the quantum kicked top operator and classified them as stable or chaotic. Then we experimentally measured the evolving probabilities of finding our AQS in these states over time, and used this to quantify leakage between stable and chaotic regions. We found these boundaries to be quite robust given the imperfections currently found in our experiment, a preliminary indicator that AQS could be useful even without error management protocols.

Sawyer Miller

Fort Lewis College

Durango, Colorado

MENTOR: Stanley Pau

Study of Thin Film Polymer Polarizer under Ultraviolet Radiation

The fabrication of liquid crystal polymer polarizers involves the use of linear polarized ultra-violet (UV) light. This work studied the change of the alignment polymer and dichroic dye when exposed to large amounts of unpolarized UV light. Samples with a protective optical coating and samples without were exposed to a UV source. Between each exposure, the samples' Mueller matrix was measured using a polarimeter. Using the Stokes vector and Mueller calculus, characteristics including transmittance, diattenuation, polarizance, depolarization index, and average degree of polarization, were calculated. These characteristics as a function of wavelength at different exposures were compared. Polarizer characteristics at 500 nm were plotted as a function of exposed energy density. A downward trend was predicted and observed for diattenuation and polarizance. An upward trend was predicted and observed for the minimum transmittance and little to no increase was observed for the depolarization characteristics. Among the different empirical models of the photodegradation of polymers, an exponential decay in azo dye concentration was found to best fit the data. The change in absorbance was calculated from the transmittance data using Beer's law as a function of exposure, data fitted an exponential decay with R^2=0.955. For the coated sample, the average transmittance remained constant at 500 nm. While there was no trend in the change in maximum transmittance for the uncoated sample, the minimum transmittance had a constant increase, correlating to the degradation of the dichroic dye and thus the qualities of the polarizer. The samples with optical coating degraded six times slower than the samples without optical coating.

Adam Moreau

University of San Diego

San Diego, California

MENTOR: DR. R. JASON JONES, JENNA BERGEVIN

Mechanical Resonance Damping for Piezoelectric-Actuated Mirror Mounts

A piezoelectric-actuated mirror with greater than 380kHz servo bandwidth was developed, and the principal factors that lead to low frequency mechanical resonances were examined. In order to keep the gain cavity length of an ultrafast laser uniform, a small piezoelectric transducer (PZT) is attached to the backside of one of the mirrors. A major difficulty encountered when working with PZT-actuated mirrors is their very limited bandwidths, often < 20-40kHz. A number of variables were considered for the design of the mounting structure, such as the size of the mounting head, the material used on the surface and the core of the mount, the type and amount of adhesive applied, the methods of application, the mass of the mirror, and fabrication techniques. Out of those analyzed, the two dominant factors, which most affect the frequency of the first resonance, are the methods for applying the adhesive, and the thickness of the adhesive used. When adhering the PZT to the mirror and mounting head, a large adhesive mound must be depressed, pushing excess material to the sides, thus eliminating irregularities within the adhesive itself and ensuring a thin, uniform layer is applied. With this addressed, secondary and tertiary factors have been shown to be the presence of a damping core to prevent longitudinal resonance modes, and the Young's Modulus of the outer materials respectively. The optimal mount design for a piezoelectric-actuated mirror is the 0.25"Ø Tungsten-Carbide filled design, with an outer material of either Brass or Copper.

Katherine Overend

Missouri University of Science and Technology

Rolla, Missouri

mentor: Rongguang Liang

On-Machine Testing of Freeform Optics using a Chromatic Confocal Sensor

This project focuses on developing on-machine testing methods in freeform optics fabrication. When an optical surface is cut using a diamond turning machine it must be removed for testing and if the surface needs to be altered or refined, it is nearly impossible to replace the surface in exactly the same position. Therefore, this process will introduce additional manufacturing errors. Furthermore, because traditional interferometric measurement methods are restricted by the surface shapes, they are not applicable for all freeform optics testing. In this study, the chromatic confocal method is investigated for on-machine metrology of freeform optics. This method does not require removing the optic from the turning machine and can measure a large variety of freeform optics with the built-in scanning mechanism in the diamond turning machine. Communication between the chromatic confocal sensor and the diamond turning machine is achieved by a custom developed program: the program tells the turning machine to move the optic incrementally to specified positions; then the sensor measures the distance of the optical surface from the probe. The combined position data from the turning machine and distance data from the sensor are saved and then used to create a 3-D image of the optical surface.

Cody Poole

Lawrence University

Appleton, Wisconsin

MENTOR: Jerome Moloney

Shrinking the Ring Resonator with Plasmonics

The Finite-Difference Time-Domain (FDTD) method was used to investigate a purely plasmonic ring resonator consisting of evenly spaced silver nano-spheres arranged in a circle. The effect of changing the number of spheres in the ring on the position of the resonances was explored. The geometry of the ring allows either the radius of the nano-sphere components or the radius of the ring formed by the components to stay constant while the other changes with the number of spheres. In all cases, three prominent resonances in the optical range were found. These resonances were seen to shift towards longer wavelengths as the radius of the ring was increased with the number of spheres. Similarly, these resonances were seen to shift to longer wavelengths as the size of the individual spheres were increased. The resonances are substantially broader than those typically seen in purely dielectric ring resonators.

Jessica Steidle

SUNY Geneseo

Geneseo, New York

mentor: John Koshel

Freeform Optics for Lighting

Lighting conditions are a major concern in the art world. Poor lighting can distract viewers, alter the emotional impact of art, and even permanently damage multi-million dollar pieces of artwork. The proposed solution is an optical system, to be used to illuminate a painting, consisting of an LED source and freeform optic to create a uniform spatial and spectral distribution of light. This system would help improve both the presentation and preservation of paintings, as well as increase efficiency. This is not a trivial problem, but involves illuminating a rectangular painting on the wall using a light on the ceiling. Freeform optics have more degrees of freedom and so can be used to solve complicated lighting problems such as this, but are challenging to design and manufacture. As part of the design process for this system, the reflectance spectrum of the painting to be illuminated, Mark Rothko's Green on Blue, was measured in order to determine the light source required to produce a uniform spectral distribution. The optical design software LightTools, assuming a point source, can generate a point cloud representation of the required freeform surface. A variety of polynomial representations of this surface were explored. These representations were evaluated by the quality of their fit to the point cloud as well as by the resulting spatial distributions of light. This will allow for the optimization of the surface to allow for an LED source, and will eventually lead to the manufacturing and testing of this system.

GRADUATE COLLEGE

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Instructors: Andrew Huerta, PhD, Renee Reynolds, ABD, Joanna Sanchez-Avila
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Coordinator: Donna Treloar, MA
Instructor: Andrew Huerta, PhD
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CAT VEHICLE PROGRAM/ ECE REU

PI: Jonathan Sprinkle, PhD
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Sponsor: National Science Foundation Research Experiences for Undergraduates Program

RESEARCH IN OPTICS (RiO)

PI: R. John Koshel, PhD
Coordinator: Melissa Sarmiento Ayala, MEd Sponsor: National Science Foundation (NSF)
Award No. 1460723.

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GRADUATE COLLEGE

Undergraduate Research Opportunities Consortium