Summer Research Institute (SRI)

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Graduate Teaching Assistants: Alyssa Higgins and Ruben Zecena, **Sponsors:** University of Arizona, University of Arizona Graduate College, Western Alliance to Expand Student Opportunities (WAESO)

Krisha Avalani

University of Arizona; Biochemistry

Mentor: Dr. Marvin Slepian – Biomedical Engineering,

Material Science and Engineering

Cell Derived Microparticles: Biomarkers for Cardiovascular Health and Disease

ABSTRACT: Cell derived microparticles are small vesicles ranging from 0.1 to 1 micrometer released by cells during cell apoptosis or cell activation (Nieri et al, 2016). Microparticles have been identified as potential biomarkers for cardiovascular health and disease. The purpose of my literature review is to evaluate the feasibility of using platelet-derived microparticles as a biomarker for cardiovascular health. Following the literature review, I will be analyzing a study, *Effect of Ticlopidine on Monocyte-derived Microparticles and Activated Platelet Markers in Diabetes Mellitus* by Shouzu et al. (2004) to better understand how microparticles are quantified and to look at a specific case study on how blood thinners affect levels of circulating microparticles. For the literature review, twelve papers are summarized to review literature which has already been published on microparticles. Following the literature review, the results and methods used by Shouzu et al are analyzed, to better understand how drugs affect circulating microparticles and an efficient method to quantify microparticles. The results of the research done by Shouzu et al. concur with previous literature. Subjects with type 2 diabetes had higher levels of circulating microparticles as compared to the control group. There was a drop in levels of circulating monocyte and platelet derived microparticles after ticlopidine was administered in subjects with type 2 diabetes. Microparticles would complement the existing diagnostic tools doctors use to evaluate the risk factor of developing cardiovascular diseases rather than it being a sole, full proof indicator.

Amber Burrell

University of Arizona; Sociology

Mentor: Dr. Celina Valencia – Cancer Center Division,

Graduate College

The Social Stratification of Sexual Misconduct: How Sexism, Racism, and Classism Determines a Sexual Misconduct Case

ABSTRACT: Sexual misconduct includes, but is not limited to, sexual harassment, sexual assault, and rape. It is widely seen that there are discrepancies in the legal system regarding who's case is pursued and the sentencing outcome of those pursued. This study analyzes the social stratification of the judge, victim, and the assailant to determine whether their social stratification position, judged by gender, race, and class, can help or hinder their trial. A social stratification scale is created to determine if and how their social stratification position helped or hindered their case. Professor Anita Hill versus Judge Clarence Thomas case is used to determine underlying sexism, racism, and classism presented in the trial by examining the rhetoric of the Senators, Judge Clarence Thomas, and Professor Anita Hill. The purpose of this study is to bring more awareness to the injustice that all women of color face when put against a system that is not in their favor. The purpose is to also highlight how sexist and racist stereotypes affect sexual misconduct cases. The study suggests that the social stratification position of the Senators and Judge Clarence Thomas being equal and two points higher than Professor Anita Hill, did play apart in the trial. The findings, however, cannot be concluded yet due to the lack of comparison of another victim with a different social stratification position and the process of their trial.

Caitlin Encinas

University of Arizona; Ecology and Evolutionary Biology

Mentor: Dr. Joellen Russell– Hydrology and

Atmospheric Sciences

The Influence of Climate Change on Southern Ocean Biological Productivity

ABSTRACT: Climate change is expected to act on the Southern Ocean's biological productivity through a poleward intensification of winds and an increase of meltwater. Since the Southern Ocean absorbs a substantial amount of anthropogenic carbon and heat, it is a vital component for climate change and the ocean. Wind stress and meltwater changes orchestrate a modification to Southern Ocean circulation, in which nutrient movement and upwelling is impacted. These physical and biogeochemical changes will influence biological productivity. To understand how sensitive ecosystems are, this research will examine previous studies to investigate biological productivity through simulations that are set to specific profiles of winds and meltwater. Simulating these changes in models allows for an observation at how biological productivity could be controlled in the future. By analyzing specific nutrients data can indicate pattern changes of biological productivity. Results show that meltwater and wind stress changes cause nutrient trapping and biogeochemical modifications that could inhibit biological productivity in the Southern Ocean. Nutrient trapping and biogeochemical changes could affect organisms' ability to thrive. Thus, biogeochemical changes and nutrient trapping could put oceanic ecosystems at risk.

Bronselaer, B., Russell, J. L., Winton, M., Williams, N. L., Key, R. M., Dunne, J. P., . . . Sarmiento, J. L. (2020). Importance of wind and meltwater for observed chemical and physical changes in the Southern Ocean. Nature Geoscience, 13(1), 35-42. doi:10.1038/s41561-019-0502-8

Justin Fleming

University of Arizona; Molecular and Cellular Biology

Mentor: Dr. Joe G. Garcia - Medicine

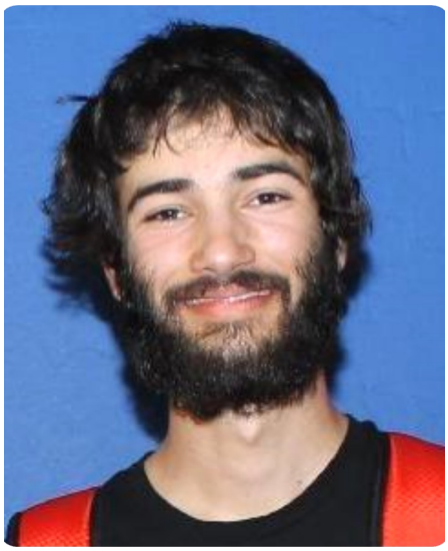
The Effect of COVID-19 on the Lung Endothelial Barrier

ABSTRACT: In many critically ill COVID-19 patients, acute respiratory distress syndrome (ARDS) develops, often leading to death. This study aims to investigate the mechanism by which SARS-CoV-2 leads to ARDS by evaluating its effect on the lung endothelial barrier. Varga et al. (2020) and Pons et al. (2020) have documented exhaustive evidence suggesting that SARS-CoV-2 primarily inhibits endothelial cell function, leading to ARDS. The exact mechanism by which this occurs is still unknown, however. The literature review conducted in this paper has identified several different hypotheses. The multi-organ endotheliitis documented by Varga et al. (2020) and Pons et al. (2020) could be caused by a direct attack from SARS-CoV-2 leading to ARDS. This model will serve as the primary hypothesis for the purposes this study. Alternatively, Mosleh et al. (2020), O'Sullivan et al. (2020), and Ackermann et al. (2020) assert that an indirect, thrombotic response to SARS-CoV-2 is responsible for the development of an albeit atypical form of ARDS. It is, however, possible that the development of ARDS in COVID-19 patients is the result of a combination of both models. To confirm or deny any of these possibilities, the direct model will be experimentally assessed by observing the effect of SARS-CoV-2 on endothelial cells, isolated from thrombotic or unrelated inflammatory effects. The endothelial cell barrier's strength can be quantified by measuring the electrical resistance of the culture. Building off the literature review in this paper, this experiment will be conducted over the fall of 2020.

Jonathan Friduss

University of Arizona; Physics, Mathematics

Mentor: Dr. John Schaibley – Hydrology and Atmospheric Sciences



Exploring Exciton Physics at a Single Moiré Site

ABSTRACT: Transition metal dichalcogenides (TMDs) are van der Waals crystals with one transition metal atom for every two group six element (chalcogenide) atoms; they are often stable in the monolayer limit. Heterostructures (structures created by placing different materials on top of each other) of single transition metal dichalcogenide monolayers are a promising platform to address many technological challenges. For example, one challenge is to use the non-classical features of objects that can only be described quantum mechanically to tractably implement algorithms that are intractable on classical computers ("quantum computing"). Heterostructures can host quantum dots—spatially confined charges that have quantized energy levels—that are possible candidates for the basic constituents of quantum computing. In 2019, multiple groups (Jin 2019, Seyler 2019, Tran 2019) found evidence that the moiré potential in TMD bilayers with a small twist angle traps electron-hole pairs (excitons); these trapped excitons are an instance of a quantum dot. But none of the studies were able to probe individual moiré sites due the spacing between sites (~20 nm) being much smaller than a diffraction limited laser spot (~1 µm). We intend to build on the work done in 2019 by fabricating bilayer TMD heterostructures with a small interlayer twist angle that allows the physics at a single moiré site to be explored.

Rebeca Garcia

University of Arizona; Mechanical Engineering

Mentor: Dr. Larry Head – Systems and Industrial Engineering

Improving Streetcar Efficiency: Model and Approach

ABSTRACT: The Tucson SunLink System is a streetcar that is a form of public transportation. Like many other streetcars worldwide, it was created to decrease the number of vehicles on the roads. The Tucson Streetcar often faces delays causing it to be less reliable, thus diminishing the original benefits. Many other public transport systems have faced delays and transportation researchers have developed multiple strategies to address this challenge. They have implemented Transit Signal Priority (TSP), Connected Vehicle Technologies (CV), and developed traffic systems to address the delays experienced at traffic signals. For this project, the focus was on developing alternative designs for improving the Tucson Streetcar system performance with minimal impact to surrounding traffic. Three approaches were explored: the creation of a new traffic signal at a location where there is often significant delay, modification of an existing traffic signal, and simulations evaluation of the Multi-Modal Intelligent Traffic Signal System (MMITSS) that can provide TSP using connected vehicle technology. A simulation of the existing traffic signal timing was created using PVT VISSIM Traffic Simulation Software. This summer, the base condition (e.g. existing condition) simulation was developed and a couple of alternative designs were modeled and evaluated. The additional alternative design simulations will be completed during the Fall 2020 semester. Data will be collected and analyzed in order to determine which approach generates the greatest improvement to the Tucson Streetcar. Decreasing the delay time experienced by the Tucson Streetcar will make it a reliable form of transportation for commuters, thus reducing the number of vehicles on the road.

Jaclyn John

University of Arizona; Applied Physics

Mentor: Dr. John Schaibley – Physics and Atmospheric Sciences

Superconducting and Optical Properties of $NbSe_2$

ABSTRACT: The first two-dimensional material was isolated in 2004. It began with graphene, but since then, other materials, like semiconducting transition metal dichalcogenides, have been studied in the two-dimensions. Research involving them is aimed at looking at their “fundamental properties and potentially new functionalities” (Koperski et al 2017).Two-dimensional NbSe2 is one of these new materials that is studied for its interesting properties. It is a known superconductor, which is a material that conducts electricity with effectively no resistance. We can observe this phenomenon at low temperatures. Graphene goes into this superconducting state when a bilayer superlattice heterostructure is created with a twist angle of about 1.1 degrees. If this same device is made with thin NbSe2, there may be enhanced superconductivity. Nonlinear optical responses of transition metal dichalcogenides is another field of promising properties that could have future applications in optoelectronics. One response that we look at low temperatures is pump-probe spectroscopy, where we see how a pump laser excites and induces changes within the optical properties of thin NbSe2. Examining how superlattices might enhance the superconducting state adds more to overall studies of high-temperature superconductors. Investigating nonlinear light-matter interactions of two-dimensional materials is another step in the direction of using them in the application of optical communication and sensing systems.

Abigail Kahler

University of Arizona; Hydrology and Atmospheric Sciences

Mentor: Dr. Ty Ferre - Hydrology and Atmospheric Sciences

Coding an Algorithm to Explore Hydrologic Decision Making

ABSTRACT: Threats of groundwater contamination can be monitored, quantified, and predicted through the use of computer models. Subsurface parameters for these models contain unknowns, and the use of multimodels can provide insight into likely outcomes to narrow the prediction focus. This is effectively done by optimizing multiple realizations of one scenario to narrow prediction uncertainty. The level of uncertainty contained and represented in the model influences future decisions, and hydrologists carry a responsibility to communicate such risk to decision-makers. Building upon these concepts creates the framework of an optimization multimodel that can be used to communicate prediction uncertainty to stakeholders. This ultimately encourages collaborative input and flexibility in exploring various interests by designing data collection around ranges of specific interest. These participatory models are at the forefront of current hydrogeology practice and are being refined to inform decision making by increasing stakeholder engagement in model design and execution. Improving model processes and results is a broad career question requiring extensive research, innovation, and practice by professionals across the discipline. The purpose of this summer research project is to develop an understanding of groundwater flow properties and computer programming to code an optimization multimodel. The algorithm developed allows the least likely models to be removed and highlights probable outcomes. This can provide insight for decision makers, but, most importantly, it communicates uncertainty by showing the variety of outcomes within any range.

Nataniel Tsai

University of Arizona; Public Health, Political Science

Mentor: Dr. Keith Joiner – Medicine

Pharmaceutical Benefit Managers and Drug Prices: What's the Link?

ABSTRACT: Pharmaceutical benefit managers (PBM) have been garnering criticism as inefficient companies who raise prices of pharmaceuticals. In light of the CVS-Aetna and Cigna-Express Scripts merger, a better understanding of the PBM market is warranted to ensure that the American pharmaceutical industry is efficient and that American consumers are able to access the drugs that they need. This paper will take a broad approach as to the impact that PBMs have on drug prices by looking at the market saturation of the PBM market through analysis published by the American Medical Association, 10K filings of CVS and Express Scripts, the two largest PBMs in the country, and investigating the various revenue streams that PBMs utilize to generate a profit and if these revenue streams have been subject to any regulatory actions by local or federal governments. There were not many general conclusions that could have been made from the data analyzed as there was inconclusive information from the 10k filings and the market is not as highly concentrated as one would think. However, the PBM market does seem to be changing rapidly due to increased usage of specialty drugs and regulatory actions. Further research would be better suited looking at a particular drugs or drug class and evaluating the effect that PBMs have on pricing.