Arts & Sciences Week

Undergraduate Student Research Lightning Talks

Hosts: Sarah Olson - Professor & Department Head of Mathematical Sciences
Craig Shue - Professor & Department Head of Computer Science

Wednesday, September 20, 2023
12:00 PM - 1:00 PM
Odeum

Fortified Foundations: Students' Research Leading the Way

Fall 2023 A&S Undergraduate Student Lightning Talks

The School of Arts and Sciences is pleased to present the research projects of the 2023 Summer Training in the Arts & Sciences Research (STAR), DraftKings, and Neuroscience Fellowship recipients. These research fellowships allow our A&S undergraduate students to conduct summer research projects with a faculty advisor. The STAR Fellowships are made possible through the generosity of the WPI Arts and Sciences Advisory Board. The DraftKings Fellowships are made possible by a generous gift from the DraftKings Corporation to support work that elevates the impact of advanced research in information science and technology. The Neuroscience Fellowship are made possible by generous donors to support students interested in the field of neuroscience.

Neuroscience Fellowship: Eva Petschek ’24
Majors: Psychological Science and Biology & Biotechnology
Advisor: Richard Lopez - Assistant Professor - Social Science & Policy Studies

Title: ***Examining Contingent Self-worth on Social Media and Implications for Enhancing Health and Well-being in Daily Life***

Abstract: In late 2021, the US Surgeon General declared a mental health crisis among youth marked by significant increases in anxiety and depression. Moreover, a recent CDC report indicated that about 30% of high school students experience poor mental health, with 3 in 5 teenage girls reporting persistent sadness and hopelessness. Some have suggested that social media use is to blame for these mental health challenges, but there has been relatively little work examining the role of psychological variables that may put young people at higher risk of experiencing depression and anxiety symptoms. Here, I focused on contingent self-worth (CSW), which reflects the extent to which one’s self-esteem is readily affected by external factors, such as others’ approval, relationships, and job performance, among others. Results from a correlational study indicated that higher CSW linked to others’ approval on Instagram (e.g., more likes received for posts) was associated with more frequent anxiety symptoms. These findings will inform my MQP study, which will employ personalized self-affirmation training that will reorient participants’ self-worth by reminding them of their core personal values, as well as encouraging participants to live out these values in their daily lives. I hope that this research will aid in the future development of personalized, psychologically informed treatments for anxiety and other mental health issues.

STAR Fellowship: Bella DeCilio ’25
Major: Biochemistry
Advisor: Arne Gericke - Professor - Chemistry & Biochemistry

Title: ***Fabrication of Giant Vesicles Containing Phosphoinositides using Nanocellulose Paper in Physiological Salt Conditions***

Abstract: Previously, cell-like model membranes, known as giant unilamellar vesicles (GUVs), were frequently assembled using a technique known as electroformation. Recently, researchers developed a more cost-effective, highyielding technique that uses tracing paper, a type of nanocellulose paper, to promote the spontaneous formation of GUVs. However, the method has only been used to fabricate GUVs from zwitterionic lipids. The aim of this study is to adapt the method for the fabrication of GUVs with anionic lipids. The two lipids we investigated are phosphatidylinositol-4-phosphate (PI(4)P) and phosphatidylinositol-4,5-bisphosphate (PI(4,5)P2). PI(4)P and PI(4,5)P2 are important signaling lipids, known as phosphoinositides (PIPs), that control numerous physiological functions. The PIP-containing GUVs were assembled by incubating a piece of tracing paper with dried lipids in a sucrose buffer with physiological salt concentrations. The GUVs were then imaged using confocal microscopy. We found that using a higher nanocellulose surface area resulted in a slightly higher yield of GUVs and less aggregation of the vesicles. Additionally, an incubation temperature of 50°C produced a higher yield of PI(4,5)P2 GUVs and larger GUVs overall than at 20°C. These findings will allow us to efficiently assemble PIP GUVs and examine the formation of PIP domains, which will be important to our understanding of phosphoinositide-mediated signaling events.

STAR Fellowship: Keelan Boyle ’25
Majors: Robotics Engineering & Environmental Sustainability
Advisor: Berk Calli - Assistant Professor - Robotics Engineering

Title: ***Searching for Gold in Ghana***

Abstract: This project’s goal is to develop software, using machine learning (YOLOv5), for a commercial autonomous vehicle (drone), training it to find and map abandoned gold mines and identify land contaminated by mercury during mining in Ghana. The software enables the drone to stitch hundreds of images together to create one large picture of the entire mining area, along with geo-locations of important landmarks. The stitching algorithm identifies inaccuracies in the image completion in real time, either accounting for them or flagging them. The results can be used by researchers to test the marked areas and mitigate land contamination by such means as planting bamboo to absorb the mercury. Once developed, the drone could be used in many other places.

STAR Fellowship: Kylar Foley ’24
Major: Physics & International & Global Studies
Advisor: Robert Krueger - Professor - Social Science & Policy Studies

Title: ***Bioremediation of Abandoned Uranium Mines***

Abstract: During and after World War II and The Cold War, The United States had an ever-growing demand for Uranium. Navajo Nation, the land of the Navajo people in Arizona and New Mexico, was able to meet a great deal of this demand. Nearly 30 million tonnes of Uranium Ore was extracted from 500 mines leased from Navajo Nation, with many Navajo people either working the mines or raising families near them. But because of uranium contamination, this agreement has left a harmful legacy, with the 500 leftover uncleaned uranium mines leaving above background uranium and radiation levels.

This fellowship paper delves into the urgent need for the remediation of uranium from these abandoned sites, focusing on the potential risks and chemical impacts associated with various forms of uranium. Moreover, it offers a comprehensive review of bioremediation techniques as a promising approach for effectively cleaning the drinking water in the affected areas.

The research highlights the dangers of uranium mines, emphasizing both the chemical and radiological effects, and how increased levels can endanger human health. The study investigates the various chemical forms of uranium and their distinct impacts on the environment to better understand which forms most need to be remediation so that the proper remediation techniques could be used.

To address this pressing issue, the paper undertakes a thorough review of bioremediation techniques, with a primary focus on phytoremediation and microbial remediation. The paper looks at different research on plants with high Uranium uptake and then compares those to which plants are native to the area. Finally, an analysis is done to determine which plants have both a potential to remediate and a potential for further research.

This research fellowship underscores the urgent need for addressing uranium contamination in Navajo Nation. It explains the significance of understanding the chemical impacts, attempts to explain those of different uranium forms, and advocates the application of bioremediation.

STAR Fellowship: Samuel Darer ’24
Major: Chemistry
Advisor: Ronald Grimm - Associate Professor - Chemistry & Biochemistry

Title: ***We Want to Cap MOFs… Do They Survive? Does Order Matter?***

Abstract: Metal Organic Frameworks (MOFs) are becoming a promising field of chemistry research. With their high porosity and variable stability, MOFs show great potential as materials with use in a wide variety of fields, from water purification, to catalysis, to use as therapeutic drug carriers. One potential means of drug delivery is through capping the surfaces of MOFs to trap guest therapeutics within the MOF high internal surface area and then control guest release. To enable targeted release, complex capping groups with designed decomposition conditions will need to be developed and attached to MOFs. One pathway to achieve this would be to construct capping groups piece by piece on the surface of the MOF. In pursuit of this, the bio-compatible MOF UiO-67 was capped with epoxide silanes which were then further modified by ring-opening the epoxide with either a fluorinated amine or carboxylic acid. The presence of surface modification was confirmed by X-ray Photoelectron Spectroscopy. Unfortunately the UiO-67 did not survive the capping process as revealed by Powder X-ray Diffraction. The next steps are to find methods of silanization that do not damage UiO-67 or to make modifications to the UiO-67 structure to increase the material’s stability, vapor phase silanization and the use of an alternate organic linker with methyl obscuring groups being pursued respectively.

DraftKings Fellowship: Jessica Liano ’24
Major: Interactive Media & Game Development
Advisors: Edward Gutierrez - Assistant Professor - Humanities & Arts
Farley Chery - Associate Professor of Teaching - Interactive Media & Game Development

Title: ***Creating Diverse Characters***

Abstract: In most forms of media, non-white groups are extremely underrepresented, and are often portrayed negatively or in an inaccurate fashion. The video game industry is no exception; the overwhelming majority of game characters are of Caucasian descent and leave little room for different stories to be told. The purpose of this research is, in tandem to the Rigs of Color project, to create premium rigs of diverse characters to promote the presence of diversity and anti-racism in education and games. At this time, I have created seven characters for an original game aimed at promoting diversity, as well as an 8th original in progress character for Rigs of Color. Each character has been taken from original concept art in Photoshop to 3D model in ZBrush, using facial and hair reference to provide accurate representation, and features a wide array of body types. The next steps are modeling shoes, completing the retopology, and creating each character’s rig so they can be used for animation. This work will be continued for the remainder of the 2023-2024 school year, focused on the development of Clean Sweep (working title), a 3D game featuring several of the modeled characters that aims to highlight stories of different backgrounds and allow others to feel seen and validated.

STAR Fellowship: Ezra Yohay ’25
Major: Physics
Advisor: Qi Wen - Associate Professor - Physics

Title: ***The role of TRPA1 Ion Channel in Shear Stress Sensitivity of Schwannoma Cells***

Abstract: The transient receptor potential (TRP) channels are involved in various nociceptive sensations such as pain and inflammation. Prior research in our lab demonstrated that TRPA1, a member of the TRP family that has been known to involve in chemical and temperature sensing, is also critical for shear stress sensing in the nociceptors of drosophila (1). In mammalian cells, the role of TrpA1 as a mechanosensory still remains controversial. Human Schwann and Schwannoma cells are known to express TRPA1 and respond to shear force (2). We aim to investigate the role of TrpA1 in shear stress sensing of human cells by comparing the shear stress responses of Schwannoma cells to those of Schwannoma cells with TrpA1 inactivated. My summer research is focused on designing and fabricating a microfluidic device, which will enable us to culture cells inside it, to deliver precisely controlled fluid shear stress to cells, and to perform fluorescence microscopy on cells. We have successfully fabricated the device, characterized the flow pattern in the device, and tested cell culture and delivering shear stress to cells in the device. Our future work will be applying the device to characterize the shear stress response of Schwannoma cells using calcium imaging and compare the responses of schwannoma cells to cells treated with drugs to inactivate TrpA1.

STAR Fellowship: Sona Hanslia ’25
Major: Physics
Advisor: Raisa Trubko - Assistant Professor - Physics

Title: ***Temperature Imaging of Diamond-Glass and Diamond-Aluminum Interfaces with a Quantum Diamond Microscope***

Abstract: Quantum sensors comprised of Nitrogen-Vacancy (NV) centers in diamond are an emerging technology for imaging magnetic fields with sub micro-Tesla sensitivity and micron-scale spatial resolution. Our aim is to develop a new application for the Quantum Diamond Microscope (QDM) with NV diamond to characterize the magnetic properties of novel biomaterials comprised of iron-chelation silk microfibers. These biomaterials can be controlled by external magnetic fields and have applications in tissue engineering. Thus, magnetic characterization is critical. However, magnetic imaging with a QDM is challenging because the biomaterials can be burned by the required laser illumination and fluorescence of the NV centers. We did thermal simulations and designed a mount that minimizes sample temperature. Using a QDM, we experimentally imaged temperatures with the NV diamond on an aluminum block versus a glass microscope slide that is traditionally used. We compared the temperature distribution of the two interfaces using diamonds with 7ppm, 4.5ppm, and 3ppb densities of NV centers. Aluminum reduced the average temperature of the 7ppm and 4.5ppm NV diamonds by 20°C, and we experimentally demonstrated a similar effect with the sample as well. Thus, swapping the glass slide for an Aluminum block allows us to increase the laser power, and in turn, reduce measurement error and increase magnetic field sensitivity to allow for magnetic imaging of a wider range of heatsensitive samples.

DraftKings Fellowship: Michael Gatti ‘24 & Bryon Tom ‘24
Majors: Computer Science & Robotics Engineering
Advisor: Walt Yarbrough - Professor of Practice - Interactive Media & Game Development

Title: ***WPI IMGD Playtesting Website***

Abstract: The IMGD program at WPI requires 2 hours of playtesting per class in order to graduate. During the 2022 - 2023 school year, an IQP group analyzed these requirements. Due to issues such as poorly made playtesting forms and room reservations being locked, they identified the need for a centralized playtesting tool. Thus, we are creating a website that will help to facilitate completing these requirements. Our website will have multiple features, with a database of the current playtesting projects being the primary focus. Each project will have its associated playtesting forms, owners, and future playtesting dates associated with it, allowing both game designers and playtesters to view all the important information within a single source. Other potential features include vocal recordings and the ability to create room reservations. This side features will address smaller concerns related to IMGD playtesting, and will help to create a smoother experience as a whole.

Neuroscience Fellowship: Max Seager ‘25
Major: Biochemistry
Advisor: Inna Nechipurenko - Assistant Professor - Biology & Biotechnology

Title: ***Genetic modeling of GNAI1 neurodevelopmental disorder in C. elegans*** **(with Rehab Salama)**

Abstract: Neurodevelopmental disorders (NDDs) comprise of a range of conditions that include autism spectrum disorders, developmental delay, and intellectual disability. Mutations in the human GNAI1 gene cause a severe NDD associated with the previously mentioned conditions. Currently, it remains unknown how mutations in GNAI1 disrupt normal neural development leading to NDD. In this project, we utilized CRISPR-Cas9 genome editing in the nematode C. elegans to introduce four NDD associated patient mutations in the C. elegans odr-3 gene, which is orthologous to the human GNAI1 gene. ODR-3 protein has 66% sequence similarity to the human Gai1 protein encoded by the GNAI1 gene, and the identified GNAI1 mutations map to identical amino acids in the C. elegans ODR-3. Furthermore, odr-3 and GNAI1 are both required for ciliogenesis in C. elegans neurons and human cells, respectively, making C. elegans an excellent model organism for studying the effects of GNAI1 mutations on neuronal development. To determine the functional consequences of the patient mutations, we used high-resolution microscopy to image cilia in C. elegans sensory neurons from animals carrying orthologous mutations. We found that odr-3(nch004[M88V]) mutants exhibit mild but statistically significant decrease in cilia size. On the other hand, the cilia morphology of odr-3(nch005[I321T]) mutants is severely disrupted. Additionally, TagRFP-tagged ODR-3[D175V] mutant protein is mislocalized in ciliated sensory neurons.