CSU
Cleveland State University

# 2023 UNDERGRADUATE RESEARCH POSTER SESSION

Student Center Atrium

**SEPTEMBER 21**
**NOON–3 P.M.**

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CSU | Office of Research

# 2023 Undergraduate Summer Research Award Poster Session

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# *The Role of the 26s Proteasome in the Second Meiotic Progression*

## College of Arts and Sciences

**Student Researchers:** Brandon Blackburn and Dr. Anshul Mishra*

**Faculty Advisor:** Valentin Boerner

## Abstract

The process of meiosis results in the production of 4 gametes (sex cells) from one germ cell. This process is pivotal to procreation as it produces haploid cells that can be paired with another set of haploid cells. For example, the sperm and the egg. A lot of essential processes go on in order to make this very delicate and vital process unfold, but we will be looking at the specific role of the 26s proteasome.

The proteasome is a multiunit enzyme that helps clean up proteins that need degraded or have been used for their function. It is made up of 4 rings, two alpha rings that make up the top and bottom of the enzyme and two beta units that make up the core. All but one of these subunits are essential to the life of the cell (the alpha 3 subunit). With this knowledge, we can delete this subunit and watch how the cell will progress through meiosis without a functioning proteasome when we otherwise would not have been able to.

*Post-Doctoral Fellow*

# *Acuity of the Lateral Line Sense of African Clawed Frogs (Xenopus laevis): Ability to Differentiate between Paired, Adjacent Wave Sources*

## College of Arts and Sciences

**Student Researcher:** Julia Rigaud

**Faculty Advisor:** Jeffrey Dean

**Abstract**

Adult African clawed frogs use their lateral line system to sense and orient towards potential prey falling into the water. Our current experiments focused on the quantitative and qualitative ability to respond to paired, simultaneous stimuli at various separations in order to test the acuity of the lateral line, i.e., its ability to resolve the paired stimuli as separate stimuli. A computer commanded plastic rods to briefly touch the surface of the water: 3 rods were used for single stimuli, and the fourth and fifth rods were paired for the acuity tests. Responses to all stimuli were video-taped and then analyzed with Python to measure stimulus angle and distance, turn angle and swim distance, latency, movement descriptors, and, for two stimuli, choice. Based on preliminary results with three frogs, 601 trials, and a 4.5 cm separation distance, frogs responded equally often to single and double stimuli. Stimulus distance, proximity to wall, frog depth and individual were significant factors but explained only 5% of deviance. Neither did stimulus number affect the frog's swim distance. Overall, frogs did not treat the paired stimuli as a single stimulus at the midpoint: linear regressions of turn angle versus the pair's mean position or versus single stimuli positions indicated similar slopes (0.73°/° vs 0.76°/°) but larger standard errors of the estimate (30.7° vs 18.4°), mean absolute errors (20.3° vs 14.0°) and less variance explained (80% vs 92%). Surprisingly, response latencies were approximately a half a second longer for two stimuli.

# *Investigating the role of the N-terminal Stag1 domain in Globin gene expression during Terminal Erythropoiesis*

## College of Arts and Sciences

**Student Researchers:** Dev R. Savaliya, Sarah Adams, Anita R. Dhara, Rachael White, Mehrael Roman, Adam Musleh, and Raja S. Sundaram*

**Faculty Advisors:** Merlin Nithya Gnanapragasam and Mahesh Ramamoorthy

## Abstract

The human genome consists of approximately 3 billion nucleotide pairs and therefore requires complex organization principles to bring precise regions of the genome together for satisfying complex DNA transactions. Some examples of these organization principles involve the formation of chromatin loops and topologically associated domains (TADs), important for transcription and recombination. The cohesin complex made up of proteins SMC1, SMC3, and Rad21 along with accessory factors, Stag1 and Stag2, mediates the formation of TADs and loops. The organization of the genome affects biological processes such as organ development, and cell differentiation, and its corruption, leads to disease.

Here, we sought to study the role of the cohesin protein Stag1 in the expression of globin genes during erythroid cell differentiation. This was done by either knocking down Stag1 gene expression using short hairpin RNAs against Stag1 mRNA or completely knocking out Stag1 gene using Clustered Regular Interspaced Short Palindromic Repeats (CRISPR) directed against the Stag1 gene. Our results demonstrate that the reduction or elimination of Stag1 significantly reduced the globin gene expression in erythroid cells. Our next step is trying to identify the exact mechanism by which Stag1 mediates the expression of globin genes. Towards this goal, we are evaluating the role of Stag1 in affecting the chromatin profile of the active genes during terminal erythropoiesis and in changing the genome organization that affects the interaction of the globin promoter with their cis-acting genome elements. Understanding how Stag1 affects globin gene expression in erythroid cells could have significant implications in the treatment of diseases such as thalassemia and sickle cell anemia, where globin expression is compromised.

**Post-Doctoral Fellow*

# *Evaluating Stag1's role in the maintenance of genome integrity during terminal erythropoiesis*

## College of Arts and Sciences

**Student Researchers:** Mehrael Roman, Sarah Adams, Dev R. Savaliya, Anita R. Dhara, Rachael White, Adam Musleh, and Raja S. Sundaram*

**Faculty Advisors:** Mahesh Ramamoorthy, Merlin Nithya Gnanapragasam

## Abstract

During cell replication, sister chromatids are held together by the cohesin complex which ensures proper replication, DNA repair, and recombination. The cohesin complex consists of proteins that form a ring-like structure and are made up of Smc1, Smc3, Rad21, and accessory proteins Stag1 or Stag2. Further, the rings are removed during mitosis, allowing proper separation of genetic material between newly replicated cells.

The cohesin components Stag1 and Stag2 have been studied extensively in different developmental backgrounds and it has been shown that they perform both redundant and exclusive functions. This observation has prompted studies on the possibility of targeting Stag1 in Stag2 mutated cancers. In this study, we evaluate the role of Stag1 in erythroid cells during their differentiation. Knockdown of Stag1 gene expression in erythroid cells and knockout of Stag1 using CRISPR were done, and the cells were then arrested at the prometaphase stage of the cell cycle, swelled in a hypotonic buffer, and dropped onto glass slides to generate metaphase spreads. The metaphase spreads were imaged and analyzed.

We observed that, in comparison to the wild-type cells, both the Stag1 knockdown and knockout cells showed defects in their metaphase spreads, from chromosomes appearing in a distinct railroad-type pattern to a few that showed complete loss of cohesion. Therefore, we conclude that Stag1 has a role in maintaining proper sister chromatid cohesion in erythroid cells and that Stag2 is unable to compensate for this function when Stag1 is lost. Further studies will expand on the mechanisms behind this observed phenotype. Upon completion, this data may yield us valuable information on why targeting Stag1 in Stag2 mutated cancers may result in inadvertent complications.

*Post-Doctoral Fellow

# *Plumes and pigments: Hyperspectral tools for water quality monitoring*

## College of Arts and Sciences

**Student Researcher:** Emily Hyland

**Faculty Advisor:** Brice Grunert

## Abstract

Water quality in the Great Lakes is increasingly threatened by human activities such as agriculture and sewage. Alongside climate change, these stressors are resulting in biogeochemical variability not previously observed, with often detrimental impacts on water quality. These changes can be observed at high spatiotemporal frequency using satellite sensors, provided the observations constrain dynamic, visible components of the aquatic system such as river plumes and pigment-rich algal blooms. These plumes and pigments are readily visible from hyperspectral sensors due to the specific ways they interact with visible light. However, to monitor these changes, flexible tools are needed to turn spatiotemporally dense hyperspectral satellite observations into meaningful data for water quality monitoring. Here, we present data from a sediment resuspension event in Lake Erie and discuss how next generation hyperspectral satellite sensors, alongside advanced tools, will change the way water quality is monitored.

# *Tagging Endogenous TbRNaseH1 for Examination of its Regulation by TbRAP1*

## College of Arts and Sciences

**Student Researchers:** Delaney Brown* and Elaina Casteel*

**Faculty Advisor:** Bibo Li

## Abstract

*Trypanosoma brucei* is a protozoan parasite that causes Human African Sleeping Sickness. The parasite is coated in variant surface glycoproteins and only one of the ~2,500 *VSG* genes is expressed at a time. As *T. brucei* multiplies in the bloodstream of its mammalian host, it undergoes antigenic variation, which allows it to evade the host's immune response. Antigenic variation is the mechanism by which these protozoans are able to alter their surface glycoproteins. This process is regulated by several telomere proteins including *Tb*RAP1, since *VSGs* are located at subtelomeric regions. Specifically, we have shown that depletion of *Tb*RAP1 leads to an increased level of telomere repeat-containing RNA (TERRA), which can form telomeric R-loops (TRL) with the telomere dsDNA. *Tb*RAP1 depletion also increases the TRL level and the amount of telomeric and subtelomeric DNA breaks as R loops have a tendency of inducing DNA breaks, which in turn trigger more *VSG* switching events. Interestingly, these defects can be suppressed by overexpression of RNaseH1. RNaseH1 is an enzyme that degrades the RNA strand in a DNA:RNA hybrid and can dissolute the R loop structure. Overexpression of RNaseH1 in *Tb*RAP1-depleted cells decreases the TRL amount, reduces the amount of telomeric and subtelomeric DNA breaks and suppresses the elevated *VSG* switching rate. However, it is unclear whether depletion of *Tb*RAP1 will directly affect RNaseHI protein level. Here we tagged one endogenous RNaseH1 allele with an epitope tag and established a conditional *Tb*RAP1 RNAi strain. We will examine the RNaseH1 protein level before and after depletion of *Tb*RAP1 by RNAi.

**Honors Student*

# *Characterize TbRAP1 Myb domain functions by mutagenesis*

## College of Arts and Sciences

**Student Researchers:** Elaina Casteel,* Delaney Brown,* and Jillian Gady*

**Faculty Advisor:** Bibo Li

## Abstract

*Trypanosoma brucei* causes human African trypanosomiasis (HAT), which is transmitted by the Tsetse fly in sub-Saharan Africa. These parasites can regularly change their major surface antigens (variant surface glycoproteins) which allows them to evade the host's immune response and establish long-term infections. Therefore, if left untreated, HAT is frequently fatal. All *VSG* genes are located at subtelomeric regions and are expressed monoallelically. Work from our lab has shown that *T. brucei* telomere proteins play important roles in antigenic variation. Specifically, *Tb*RAP1, a telomere protein, is essential for *VSG* monoallelic expression and suppresses DNA recombination-mediated *VSG* switching events.

*Tb*RAP1 has several functional domains and we have shown that the BRCT1 domain is essential for a normal *Tb*RAP1 protein level, while the Myb domain is critical for interacting with *Tb*TRF, another telomere protein that binds to the duplex TTAGGG repeats. In this experiment, we are investigating the consequences of mutations occurring in the BRCT1 and Myb domains of *Tb*RAP1. The predicted BRCT1 domain has an uncanonical insertion, so we would like to delete this insertion to determine its functional consequence. The Myb domain is also predicted to form a non-classical Myb-like structure, so we would like to delete the individual helices and beta sheets to determine whether this region is essential for TbRAP1's function. We have generated four deletion mutations in the BRCT1 and Myb domains of TbRAP1. In the future, these mutants will be targeted to replace one endogenous TbRAP1 allele in cells where the other endogenous TbRAP1 allele is flanked by two loxP repeats. Inducing Cre expression will delete the floxed TbRAP1 allele and allow us to examine the phenotypes of the TbRAP1 mutants.

**Honors Student*

# The Influence of Wax on Leaf Reflectance in Diverse Tree Species

## College of Arts and Sciences

**Student Researcher:** Cyenna Ulrich-Cech

**Faculty Advisors:** Kevin Mueller, Brice Grunert, and Daniel Griffith*

## Abstract

New hyperspectral sensors on satellites and planes monitor electromagnetic radiation covering most of the Visible to ShortWave InfraRed (VSWIR) range, enabling deeper investigation into absorbance and reflectance patterns of earth's features[1]. The improved measurements provide more context for ecosystem processes; for example, using remotely sensed data from imaging spectrometers to quantify net primary production (NPP)[2]. Light interacts with plants through absorbance, transmittance, and reflectance, dependent on chemical and structural plant characteristics like leaf chemistry, anatomy, morphology, etc., thus leaves of different plant species have distinguishable reflectance spectra[3]. Diverse spectral signatures in VSWIR radiance, however, create 'mixed' signals which must be decoded to comprehend leaf reflectance and its relation to ecosystem processes[4]. Leaf surface wax morphology, depending on the chemical composition of the wax, varies by species and constitutes the outermost layer of a leaf, inevitably influencing leaf reflectance[5]. Despite this significance, there is limited research on the influence of wax on VSWIR reflectance. This study seeks to record reflectance spectra of 43 diverse tree species and document potential relationships between spectra and leaf surface wax. Samples were collected, prepped, and processed in the lab in which reflectance spectra were collected pre and post wax extraction. The average reflectance percentage pre-extraction was 39.9% and post-extraction was 38.9%, with 46% of the tree species showing a negligible difference pre and post extraction. The lowest LDMC value observed was 0.36 g/g and the highest was 0.80 g/g. The lowest lipid mass per dry mass value observed was 0.26 mg/g and the highest value 10.21 mg/g. The differences in the total reflectance percentages pre and post wax extraction are not substantial enough among these common temperate broadleaf tree species to establish a trend, however leaf surface wax morphology varies by species which could explain the varied reflectance. Future studies should explore other leaf surface wax traits such as thickness or composition that likely influence leaf reflectance.

**Visiting Professor, Wesleyan University*

# *Potential Impacts of Beech Tree Decline on Red-Backed Salamanders, Plethodon cinereus*

## College of Arts and Sciences

**Student Researchers:** Brayden Norris, Elijah Williams, and Allison Wierzbowski

**Faculty Advisor:** B. Michael Walton

## Abstract

The red-backed salamander (*Plethodon cinereus*) is a fully terrestrial amphibian commonly found in beech-maple forests of eastern North America. It plays a crucial role in the forest floor ecosystem, regulating invertebrates and contributing to proper nutrient cycling and leaf litter decomposition. However, beech trees of its preferred habitat are currently threatened by several invasive species. This study aims to determine if a significant decline in beech trees could have negative impacts on the abundance of *P. cinereus*. Cleveland Metroparks in North Chagrin, South Chagrin, Rocky River, Euclid Creek, and Big Creek were examined from June to August, with 21 sites (20 m x 20 m quadrats) randomly selected among the 5 parks. In each quadrat, the surrounding tree community was characterized using the point-quarter method. Closest trees to several randomly selected points in NE, NW, SE, and SW directions were identified by species and measured for circumference and point-to-plant distance. The quadrat was then searched for all potential cover objects (logs, bark, rocks, etc.), measuring the length, width, and underlying temperature of each. Any salamanders found underneath were measured for snout-vent length and mass, then released. The collected data was analyzed in Excel and SPSS, indicating positive correlations between the number of beech trees and the number of salamanders ($p < 0.001$), as well as between the total basal area of trunk cover and salamanders detected ($p < 0.001$). A negative correlation was found between number of sugar maple trees and detected salamanders ($p < 0.001$). In addition, multiple egg clutches were found, but only in sites populated with large beech trees. The data provides significant evidence that *P. cinereus* is most likely to be found in old-growth, mature forests that primarily consist of beech trees. The decline of these beech trees raises significant concerns for the future health and abundance of red-backed salamanders.

# *The role of MyoD phosphorylation in the regulation of skeletal myoblast differentiation*

## College of Arts and Sciences

**Student Researchers:** Bushra Damra and Ara Mendez

**Faculty Advisor:** Crystal M. Weyman

## Abstract

We have reported that cell death (apoptosis), rather than differentiation, occurs in roughly 30% of skeletal myoblasts induced to differentiate. By ectopically expressing the muscle regulatory transcription factor MyoD in fibroblasts, we have also determined that changing a particular serine in MyoD to an alanine which cannot be phosphorylated does not permit cell death in response to culture in differentiation media. However, for this version of MyoD to be a potential therapeutic utilized to increase the efficiency of muscle regeneration, this version of MyoD must induce differentiation, whereby myoblasts to fuse into multinucleated muscle fibers. To this end, we are optimizing two key protocols. The first is to determine the protocol to analyze the percentage of fibroblasts ectopically expressing MyoD. We have determined two protocols that permit the detection of 88-91 % of MyoD expressing fibroblasts. The second protocol being optimized is to analyze fusion. Fusion is assessed by counting the number of cells with greater than two nuclei. This requires clear photos shot through a microscope lense. Step one was to compare an android phone camera to an iphone camera. We have determined that the iphone provides better picture quality for the purpose of counting multinucleated cells. We have thus far determined that plating myoblasts at 2 million cells/100 mm dish followed by culture in 15% horse serum for 24 hours resulted in 3% fusion. Future experiments will involve plating cells at a lower density followed by culture in less horse serum for a longer time frame.

# *Lectin-Mediated Insights on Desialylation of Macrophages during LPS Stimulation*

## College of Arts and Sciences

**Student Researchers:** Jonathan Nitardy and Majdi A. Aljohani

**Faculty Advisor:** Xue-Long Sun

## Abstract

Sialylation is a regulated process, and its pattern and density can vary depending on the cell type, developmental stage, and physiological environment. This process can be described as the addition of Sias to the terminal ends of Glycans. Contrarily, desialylation is the removal of Sias from the terminal ends of glycans, catalyzed by sialidase. It has been shown that several diseases, including some immune diseases and neurological conditions may be a result of desialyation. Previous studies confirmed that lipopolysaccharide (LPS) induces endogenous sialidase expression in monocytes and macrophages, which could cause increased desialylation in LPS receptor TLR4, leading to the LPS/TLR4 signaling pathway. We found that the total Sia level reduces significantly in macrophages upon LPS stimulation by using different lectins such as RCA, ECL, and PNA which detect the changes in glycan structures on the surface of THP1 Macrophage, including the removal of sialic acid. These results were consistent with flowcytometry using FITC conjugated lectins. This could suggest that the endogenous sialidases expression and activities increase significantly upon LPS treatment. In the future sialidase inhibitors could be used to determine if they can counteract the removal of sialic acid caused by LPS-induced desialylation and subsequent biological processes and cellular functions.

# *Synthesis of lysosome-directed sialidase inhibitors*

## College of Arts and Sciences

**Student Researchers:** Sophie J. McIntyre and Isaac Turan

**Faculty Advisor:** Xue-Long Sun

## Abstract

Sialidase in mammals exists in four isoforms, NEU1, NEU2, NEU3, and NEU4. Each isoform of sialidase exists in distinct subcellular environments and they have various functions at each location within the cell. In order to elucidate the function of each sialidase isoform, a great deal of location selectivity is required due to the variety of sialidases found within cells in various cellular locations. Current chemical inhibitors do not provide sufficient ability to target cellular locations to examine the function of different sialidases, nor to examine the same sialidase in different cellular locations. NEU1 is known to exist both on the cell surface and in the lysosome. On the cell surface, it plays a crucial role in signal transduction and cell-cell interactions by removing sialic acid residues from glycoproteins and glycolipids. In the lysosome, it plays a catabolic role in removing sialic acid from their parent glycoconjugates, allowing the breakdown of waste products. Developing agents which can target a singular cellular location is necessary to elucidate the function of the same isoform at different locations. Morpholinyl groups have previously been used in the design of fluorescence probes to direct compounds towards the lysosome. Attaching a morpholinyl group to a known NEU1 inhibitor could potentially impart greater targeting ability towards lysosomal sialidase. Neu5Ac2en-9-Mor-OAc-OMe was synthesised from commercially available sialic acid with 18.6% overall yield and was characterized via NMR.

# *Identification of Drug Molecules Suppressing the Expression of HIF-1α to Treat Hepatocellular Carcinoma (HCC)*

## College of Arts and Sciences

**Student Researchers:** Gena Asi and Uthman Alghamdi

**Faculty Advisor:** Aimin Zhou

**Abstract**

The most common primary liver cancer in adults is hepatocellular carcinoma (HCC), which is the third-highest cause of cancer-related death worldwide. During solid tumor growing, due to insufficient blood supply, the tumor usually is devoid of oxygen and nutrients, resulting in the formation of a hypoxic environment that downregulates the metabolic process, leading to cancer cell death. To overcome hypoxia and continue growing, cancer cells produce hypoxia-inducible factor-1 (HIF-1), which alters their metabolic pathways and allows them to survive. HIF-1alpha (HIF-1α) is an oxygen-sensitive protein that can be overexpressed in hypoxic conditions. HCC cells cannot proliferate under hypoxia without a high level of HIF-1α expression, making HIF-1α a potential cancer treatment target. In this study, we constructed a specific cell line in which the promoter of HIF-1α is linked with the luciferase reporter gene. By using the cells, we screened the library of pharmacologically active compounds (LOPAC) and identified several compounds that are able to inhibit HIF-1α expression. The inhibitory effect of these compounds in the expression of HIF-1α in SK-HEP1 cells, a human liver cancer cell line, was further confirmed by using luciferase activity assays and Western blot analysis. Our results may provide novel drug candidates for HCC treatment.

# *Documentary Storytelling and Community Narratives: Local Stories with Global Resonance*

## College of Arts and Sciences

**Student Researcher:** Jonathan Carpenter

**Faculty Advisor:** Cigdem Slankard

## Abstract

This project focuses on three documentary films exploring narratives from Northeast Ohio, with a specific focus on marginalized communities in three different contexts, including refugee resettlement, Covid 19 pandemic, and lead poisoning.

# *Equations and Symmetry*

## College of Arts and Sciences

**Student Researchers:** Garrett Peto and Shereen ElFadil

**Faculty Advisor:** Federico Galetto

## Abstract

A system of polynomial equations may be qualitatively studied using algebra and geometry. Knowledge of the relations among the equations of a system is particularly useful. When the system exhibits a high degree of symmetry, these relations can be described using the theory of group representations. Our project aims at collecting and interpreting through this lens data about several different systems of equations appearing in the literature.

# *Coding Theory: Diving into Linear Codes*

## College of Arts and Sciences

**Student Researchers:** Taylor Vidmar and Justin White

**Faculty Advisor:** Hiram Lopez

## Abstract

Coding theory is a critical topic of research that examines reliable forms of communication through different channels. We assess types of linear codes through finite fields using Macaulay2. We focus on linear codes, specifically Subfield Subcodes and Reed-Solomon Codes.

In addition, we provide an algorithm for finding codewords in a restricted finite field.

# *Characterizing Pentacene Thin Film Growth on HOPG*

## College of Arts and Sciences

**Student Researcher:** Grace M. Miller

**Faculty Advisor:** Jessica E. Bickel

## Abstract

While they are generally more cost effective and environmentally friendly compared to their inorganic counterparts, organic semiconductors are typically less conductive. Their conductivities can be improved by creating crystalline films, which makes the distance between adjacent molecules uniform and allows for easier electron movement between adjacent molecules. One method for crystallizing organic materials is self-assembly on atomically ordered surfaces. In this work, Pentacene is thermally evaporated onto HOPG using a line-of-sight evaporation method. The resulting films are characterized by Scanning Tunneling Microscopy (STM) with the goal to determine ideal pentacene parameters for thin-film evaporation. While most trials tended to have disorganized depositions, we observed pentacene forming organized structures in two trials. In the first, we observed a honeycomb structure with a periodicity of 9.4nm. We compared the unit cell spacing to the dimensions of both a single pentacene molecule and pentacene's general triclinic crystal structure but neither fit our sample. A second organized trial showed a slightly smaller repeating pattern along a step edge with a spacing of 4.4nm. While not crystalline, this structure was periodic in the single dimension of the step edge. This structure was only compared to a single pentacene molecule, as the structure was a similar height to a monolayer of pentacene, but again the values do not quite match our structure. While we were unable to determine exactly how the pentacene molecules were forming on the substrate, our work shows pentacene's ability to form organized structures.

# *Achieving Reproducible Atomically Smooth Au(111) Surfaces*

## College of Arts and Sciences

**Student Researcher:** Jordan A. Miller

**Faculty Advisor:** Jessica E. Bickel

## Abstract

Organic electronics can be more eco-friendly but struggle to compete with inorganics due to their low conductivity. The conductivity can be increased through crystallization, and we examine surface reconstruction driven self-assembly. This work aims to obtain an atomically flat Au(111) surface reconstruction through flame annealing. The sample is held in a nitrogen environment and heated at one or two temperatures for fixed times then allowed to cool to room temperature. In this work, we vary the temperatures and time of the anneal process and characterize the results using scanning tunneling microscopy (STM). We find that temperatures above 730°C roughen the Au (111) surface or take the Au (111) off completely. Examining the effect of time at the higher temperature (previous work) did not show a trend in smoothing so this summer we examined lower temperature two-stage annealing (650°C for 1min/400°C for 1min) and just low temp annealing (450°C for 2 minutes). The two stage still resulted in a rough surface though the low temperature anneal shows hints of terrace edges. However, longer times did not result in flat terraces. Finally, during this we noted an optical change when the Au surface appeared to be highly reflective leading us to examine this transition (700°C for 1 minute). Again, there are some indications of flatness, but fully flat terraces have not yet been achieved. Future work will include testing longer anneal times at lower temperatures with a broader flame to reduce the temperature gradient of the flame to obtain larger, flatter terraces.

# *Study of Micromixing Systems using Extensional Flows*

## College of Arts and Sciences

**Student Researcher:** James Taton

**Faculty Advisors:** Petru S. Fodor and Chandrasekhar R. Kothapalli

## Abstract

Using computational fluid dynamics, the effect of implementing constrictions, defined by inverse functions, on the mixing performance of microfluidic devices operated in the laminar flow regime is investigated. The proposed designs combine uniform stretching flows generated by the hyperbolic constrictions with sheer flows resulting from the centripetal forces experienced by the fluids as they are directed along serpentine channels. Data showed that the mixing index is maximized for narrow and long constrictions. However, the required pressure differential for this global maximum in the mixing performance is also increased. Using in addition to the absolute mixing index measure, a cost of mixing measure as well, allows for a better optimization of the designs.

# *Analysis of Marine Stratocumulus Clouds With and Without a Diurnal Cycle Using Large Eddy Simulations*

## College of Arts and Sciences

**Student Researcher:** Jeremiah Greene

**Faculty Advisor:** Thijs Heus

**Abstract**

Fog and Marine Stratocumulus Clouds are one of the largest unknowns in climate, and crucial for aviation, agriculture, and solar energy. In this study, we use a detailed computer model (LES) to study the diurnal cycle of these clouds.

The simulations used unique combinations of initial boundary conditions for specific humidity, temperature, and subsidence with, and without a diurnal cycle.

The clouds properties are analyzed once the LES reaches equilibrium. The cloud top, cloud base, and total liquid water content.

The simulations show cloud formation and thickness are dependent on the difference in humidity and temperature between the sea surface and the tropospheric layer.

# *Solvent Effects on the Interaction of Charged Nanoparticles*

## College of Arts and Sciences

**Student Researcher:** Joseph Ball

**Faculty Advisor:** Sebastian Sensale Rodriguez

## Abstract

Self-assembly is ubiquitous in nature, allowing for the bottom-up construction of ordered structures via non-covalent interactions. These mechanisms have found multiple applications in chemistry and materials sciences, providing low-cost, highly reproducible, highly tunable strategies for the construction of multidimensional structures with very high yield. The goal of this project is to computationally demonstrate a novel technique for tuning nanoparticle aggregation by controlling nanoparticle-solvent interactions at the molecular-level.

# *Developing SAXS Methodology for Solutions of Polystyrene Spheres*

## College of Arts and Sciences

**Student Researchers:** Collin Douglas and Patrick Herron

**Faculty Advisor:** Kiril A. Streletzky

## Abstract

Attempts to study solutions of hydroxypropyl cellulose (HPC) microgels using small angle x-ray scattering (SAXS) were performed at Kent State University's AMLCI lab to expand on and verify previous results from static and dynamic light scattering. However, the results gathered from our initial methodology did not reflect the results previously gathered nor made sense within the context of SAXS. From these issues an entirely new methodology for running and analyzing SAXS results needed to be created by adjusting parts of the initial methodology. By deciding to use water-based solutions of Polystyrene microspheres (PS) with the same size range we were able to utilize a sample with a known size and shape to self-teach SAXS and introduce corrections to our methodology. To improve we needed to eliminate masking, match detector and distance settings to sample sizes, determine scaling factors and ranges, improve calibration procedures, and determine a fitting procedure in SASVIEW that accounts for program sensitivities. By taking a meticulous step-by-step approach to every part of our process we were able to improve our methodology and create a process that yields much more accurate and consistent results for the sizes of probes than what was initially utilized. We now plan to apply this methodology to HPC microgels in hopes of deducing their internal structure.

# *Performing Small Angle X-ray Scattering (SAXS) on Polystyrene Probes and Polysaccharide Microgels*

## College of Arts and Sciences

**Student Researchers:** Patrick Herron and Collin Douglas

**Faculty Advisor:** Kiril A. Streletzky

## Abstract

Small angle x-ray scattering (SAXS) is a scattering technique that can be used to determine the average size, shape, and internal structure of nanoparticles in solution. Visible light scattering can also be used to determine size and shape distributions, but SAXS provides a wider q-range and ability to probe internal structures. The higher q-range also allows examination of smaller particles and portions of large particles. Unlike visible light scattering, SAXS yields information on the internal structure of particles as X-rays penetrate many non-transparent materials and have enough resolution to probe small structural elements. This project is focused on SAXS measurements of polystyrene spherical standards of various sizes (24-450 nm in diameter) with eventual goal of applying it to similarly sized polysaccharide microgels. Here we present the results obtained from SAXS measurements at Kent State University using the Xenocs Xeuss 3.0 system using a procedure developed by us. Our SAXS results on polystyrene hard spheres generally agree their specs. Our initial microgel results are much more tentative. Moving forward, we plan to expand our microgel runs applying the vast experience of SAXS on polystyrene probes with hopes to gain some information on the internal structure of the microgels.

# *Arab Youth Experiences in High School: How Experiences Within the Classroom Impacts Individual Students Sense of School Belonging*

## College of Arts and Sciences

**Student Researchers:** Rawan Almallad and Andreea Neamtu

**Faculty Advisor:** Shereen Naser

## Abstract

This study aims to explore the high school journeys of Arab youth, specifically delving into their development of identity, emotional encounters, and their integration into the broader society. Recognizing the marginalized position of Arab youth, the study underscores the potential psychological repercussions of unhealthy identity formation, as indicated by Spiegler et al. (2019). This research seeks to bridge an existing knowledge gap, highlighting the imperative of comprehending the distinctive experiences of Arab youth during their high school years.

The central research inquiry revolves around the high school experiences of Arab students, with a particular emphasis on their Arab identity and emotional engagements. Supplementary queries delve into the incorporation of Arab identity within their communities and the emotional ramifications of these encounters. The primary method of data collection will involve qualitative interviews, featuring a cohort of 10 to 15 middle eastern high school students across northeast Ohio.

In addition to interviews, this study entails intensively examining textbooks to assess how Arab history is portrayed within educational materials. The envisioned outcomes encompass a deeper insight into the experiences of Arab youth in U.S. educational institutions, making a valuable contribution to the field of psychology while also fostering research and dissemination skills. However, it is essential to acknowledge certain limitations, such as potential inaccuracies in participants' recollections and limited control over external variables.

Despite these constraints, this study presents an invaluable opportunity to illuminate a pivotal aspect of Arab youth's lives, their high school experiences, ultimately contributing to a more holistic comprehension of this subject matter.

# *Color-Word Contingency Learning with Unfamiliar Characters*

## College of Arts and Sciences

**Student Researchers:** Mackenzie Palmer and Akshra Lnu

**Faculty Advisor:** Albert Smith

## Abstract

When people are asked to identify the color of words when there is a relationship between word identity and color, response time can be influenced by irrelevant word identity. The relationship between word identity and color is built into a stimulus set by having each word occur frequently in one color (high-contingency items) and rarely in other colors (low-contingency items). (Instances of words that occur equally often in each color are no-contingency items.). The contingency effect is displayed when a participant responds faster when a word appears frequently in a color than when it appears rarely in that color. We investigated whether manifestation of the contingency effect depends on the familiarity of the characters in which the words are presented. We hypothesized that for words presented in familiar characters, we would observe the contingency effect relatively immediately, but that for words presented in unfamiliar characters, the contingency effect would, at best, develop with experience. Participants made speeded judgments of the color of stimuli in unfamiliar characters (Korean words) and familiar characters (English words) presented in blocks of trials that included high, low, and no contingency items. Each of three words had a high probability of occurring in one color, a low probability of occurring in the other two colors, and one word occurred with equally in each of the three colors. Each participant completed 8 blocks of 48 trials with stimuli from each language; language order was counterbalanced over participants. Consistent with our expectations, we found a sizable contingency effect with English words and a negligible contingency effect with Korean words.

# *Inclusive Strategies for Student Success in Health Professional Education*

## College of Health

**Student Researcher:** Ashley Banas

**Faculty Advisors:** Manuella Crawley, Jodi DeMarco, and Gina Kubec

## Abstract

Background: The College of Sciences and Health Professions Equity Task Force at Cleveland State University (CSU) discovered that Black, Indigenous, and People of Color (BIPOC) students were less likely to remain health majors and were less likely than their white counterparts to earn an A or B in the Introduction to Health Science course, a gateway course for all health professions majors (2021). This finding was of concern as it may be a root cause of decreased diversity within healthcare professions.

Objectives: Complete a literature review to identify best practices to support the success of BIPOC students in health professions education as well as identify strategies and practices to support faculty in the implementation of diversity, equity, and inclusion (DEI) concepts in health sciences curriculum.

Methods: Multiple databases were searched; Medline, PubMed, CINHAL with full text, Education Research Complete, ERIC, and CSU's "OneSearch." The search resulted in 375 articles, of which 123 were screened for closer review, and 31 were included in the study. These articles emphasized practical ways to include DEI techniques in science and health college classrooms or outlined ways to equip faculty with the knowledge and confidence to implement DEI strategies in their courses.

Conclusion: Two themes emerged within the evidence-based strategies; 1) faculty-level interventions and 2) institutional and departmental interventions. A list of evidence-based strategies for DEI program development was created which will be utilized to support the academic success of students as well as assist in faculty development within the College of Health.

# *Determination of Corticosterone Levels in Blood Serum of Brainstem Electro-stimulated vs Unstimulated mice*

## College of Health

**Student Researchers:** Mikayla Wiemels, Mohammed al Tameemi, and Nisrine El Fardassi

**Faculty Advisors:** Michael D. Hammonds and Tony L. Sahley

## Abstract

Auditory dysfunction can be intensified by stress. One of the ways to determine stress levels is by measuring corticosterone levels in blood serum. Corticosterone is a stress hormone produced by the adrenal glands under the control of the central nervous system (CNS). This study addressed the **Research question**: Will stimulation of locus coeruleus (LC) increase corticosterone concentrations above unstimulated levels? Previous findings suggest a link between stimulation of locus coeruleus and an increase in corticosterone concentration in blood serum. **The hypothesis** of this study was that there is a positive relationship between the activation of locus coeruleus and elevated corticosterone levels. Stereotaxic surgery, electrophysiology, and ELISA were the methods used to generate the data that tested the hypothesis. Statistical analysis confirmed significant differences in corticosterone blood concentration between stimulated and control mice. LC stimulation in these experiments provided evidence that ultra small concentration analytes can be measured with ELISA using stress hormones. Future research direction will involve measuring the analytes of inflammatory compounds instead of anti-inflammatory stress hormones.

# *Effects of speed on measures of stability during quadrupedal locomotion*

## College of Health

**Student Researcher:** Catherine A. O. Cornelius

**Faculty Advisor:** Andrew R. Lammers

## Abstract

Stability during locomotion is essential for the survival of animals. Animals (and humans) can improve their stability by moving slower, increase the duration of the stance phase of locomotion, and moving the center of mass closer to the substrate. These are all aspects of *static stability*. However, the movement of the animal can contribute to stability – this is called *dynamic stability*. In this study, we examined the possible impact of speed on the dynamic stability of rats. We constructed a rope-mill, which is the arboreal equivalent of a treadmill. Seven rats were trained to walk or run at 28, 45, and 57 cm/s (here we present data on three of those individuals). We filmed the animals from two high speed cameras (210 Hz), and then digitized the videos to measure the three dimensional coordinates of the shoulder, hand, hip, and foot over the course of 15 consecutive strides. We measured the semi-circular distance spanned by the hand and foot during each stride ("circumference"). We also measured duty factor, which is the ratio of stance duration to stride duration. We found that circumference was greatest at slow and fast speeds. We also quantified the amount of kinematic variability within individuals at different speeds. We found that each of the three animals had differences in how variable their locomotion was at different speeds. We conclude that increased speed did not appear to augment stability. There are considerable differences in how these animals respond to a neuromuscular challenge.

# *Understanding the Clinical Research Associate Profession*

## College of Health

**Student Researcher:** Aya Al-Hayali

**Faculty Advisors:** Joanna DeMarco and Anne Su

## Abstract

A Clinical Research Associate manages a clinical research experimental study. The CRA must follow up with the study subjects to ensure they are following the experimental protocol and contributing valid results. The objective of this research project was to explore academic training pathways for students who are interested in becoming a Clinical Research Associate. Literature and internet searches were conducted to find current CRA programs offered at other universities. Most of the CRA programs were either a 6-month to 2-year online certificate program or a 4-year bachelor's degree program. The common courses to all CRA programs are Clinical Research Design, Biostatistics, Epidemiology, Scientific Writing, and Bioinformatics. An important finding during the research was that Clinical Research Associates are also known by a variety of job titles specific to their organization, including clinical research specialist, clinical research nurse, clinical research coordinator, and a clinical research supervisor, which are not necessarily linked to educational level. The results of this study will assist in the development of a training program at Cleveland State University to meet the regional demand for Clinical Research Associates.

# *Integrating Music Therapy and Speech-Language Pathology: Application of an Interprofessional Education Training Model to Treat Children with Communication Disorders*

## College of Health

**Student Researcher:** Leanne Eichorn

**Faculty Advisors:** Lori Lundeen-Smith and Deborah Layman

## Abstract

This feasibility study explored the development and implementation of a collaborative model for integrating music therapy with speech and language pathology to treat individuals with autism and communication disorders. This project examined the effectiveness and acceptability of this model, with a focus on the responsiveness of clients, students, and supervisors. The outcome of this project was a foundational pediatric clinical training model that can be used during future collaborations between student professionals and supervisors within a university clinic environment.

The collaborative model was designed prior to the integrative treatment with the client, and implementation and refinement of the model continued throughout the semester. The speech-language pathology grad student developed goals for the client and the music therapy student, with guidance and coaching from the music therapy faculty supervisor, explored the methods in which music therapy could effectively support and enhance the client's progress in therapy. Both faculty supervisors (music therapy and speech-language pathology) observed each session and gave collaborative training feedback to both students. Within these feedback training meetings, the supervisors and student discussed goals and objectives and the role of the music therapy within the speech-language session.

The training model used provides a base for educators and future therapists to continue to develop effective interprofessional collaboration models that benefit clients.

Keywords: interprofessional collaboration, speech and language therapy, music therapy, training model

# *Knee flexion as an indicator of instability in balance exercises*

## College of Health

**Student Researchers:** Kaitlyn Boellner, Bilikisu Amunikoro, Megan Bell, and Zimiego Smith

**Faculty Advisors:** Debbie Espy and Anne Su

## Abstract

**Introduction:** As people age, their balance tends to decline which impacts their safety and independence [1]. Balance exercises are a necessary component of preventing falls and retaining independence in older adults [1]. In order to accurately prescribe these exercise treatments for patients, a clinician must consider the frequency, intensity, type, and time of exercise [1]. In order to quantify balance intensity, Espy et al. created the Rate of Perceived Stability, a 10-point scale similar to the established Rate of Perceived Exertion [2]. Due to the subjective nature of the self-rated RPS, more objective, behavioral indicators of instability are needed to help correctly dose balance exercises at appropriate intensities.

**Purpose:** This project aims to evaluate changes in knee flexion as a behavioral method of maintaining balance. This project will analyze changes in knee flexion during balance exercises on different surfaces to provide a visible, objective measure of instability that can be used to correctly dose intensity of balance exercises.

**Methods:** This study used data from a 2017 study that used the RPS to indicate balance intensity. Participants in this study played a Target Kick game on the Xbox (Microsoft Corp. Redmond, WA) on four different surfaces: floor, mats, rocker, and a slip surface. Knee flexion data from fourteen participants was reanalyzed in Cortex (Motion Analysis Corp. Rohnert Park, CA) based on the RPS score and/or presence of unstable kicks. Cortex videos were reviewed to determine if a kick appeared to be unstable.

**Results:** Unstable target kicks on the floor and mats tended to have an increase in knee flexion leading up to the time point of instability. On the rocker, knee extension preceded moments of instability. Results of changes in knee flexion angles were mixed on the slider, which is also the most complex surface of this study.

**Conclusion:** While changes in knee flexion appear to be a contributing factor in instability during static to dynamic balance exercises such as kicking, knee flexion is only one behavioral pattern. More behavioral components of human balance should be considered in order to gain greater insight into what movements lead to instability during balance exercises. This will help clinicians better dose the intensity of balance training programs objectively, which will hopefully help patient outcomes. We also must consider that not every person will exhibit the same balance strategies. Every patient varies in their behavioral patterns of how they prevent falling.

# *Let's Talk About Sex…Education!*

## Levin College of Public Affairs and Education

**Student Researchers:** Daylun Armstrong and Harper Mancuso

**Faculty Advisors:** Elizabeth Goncy, Katherine Clonan-Roy, Kimberly Fuller, and Shereen Naser

### Abstract

Through this project we provided an in-depth review of a comprehensive, inclusive sex education curriculum created by the THRiVE Collaborative at Cleveland State University and the LGBT Center of Greater Cleveland. This process included individually assessing each module of the content and providing critiques and/or detailing suggestions to possibly implement. Some of the topics within this curriculum include, but are not limited to: sexuality and gender identity, consent and healthy relationships, as well as how sex and intimacy can be different for everyone. This curriculum takes into account recent qualitative and quantitative research conducted by THRiVE on inadequacies in sex education such as, HIV/STI (Human Immunodeficiency Virus/Sexually Transmitted Infection) risk, the LGBTQ+ youth need for affirming and relevant sexual health information, culturally inclusive education, and the importance of highlighting diverse sexual experiences outside of heteronormativity and cisnormativity. In addition to this, perspectives during sessions with youth researchers' who are a part of the THRiVE program YRSC (Youth Research for Social Change), were also taken into consideration during the curriculum review process. This project is vital due to the current legislation attempting to be passed into law that is stripping the rights, sense of safety, and bodily autonomy away from LGBTQ+ youth. It is necessary that youth get relevant up-to-date comprehensive medical information within sex education that supports, represents, and affirms who they are.

Keywords: comprehensive, consent, curriculum, gender identity, HIV, inclusive, LGBTQ+, sex education, sexual health, sexuality, STI

# *The Use of Artificial Intelligence in the Diagnosis, Treatment, and Intervention of Individuals with Special Needs*


## Levin College of Public Affairs and Education

**Student Researchers:** Allison Delmonico and Nina Abercrombie

**Faculty Advisor:** Xiongyi Liu



## Abstract

In this sponsored research project, we seek to assess the various implementations of artificial intelligence in diagnosing, treating, and monitoring special needs and disabilities in individuals. Automating the processes required to diagnose and treat individuals with disabilities assists individuals in receiving the care and relief needed in order to lead comfortable lives. We conducted a literature search of journal articles published in the past ten years using a variety of research databases. We focused specifically on developmental (autism, ADHD, stuttering, and learning disabilities) and emotional-behavioral disabilities. For developmental disabilities, we generated 900 total results with our search criteria. For emotional-behavioral disabilities, we generated 357 total results. Out of these searches, we only found 39 and 25 relevant articles for developmental disabilities and emotional-behavioral disabilities, respectively. Many of the articles we found used various sensors in order to capture data for the algorithms to interpret. We noted research gaps in the identification of emotions, classification of utterances, extraction of audio data, and the assimilation of skills, as well as in the extraction of data from user phone usage, the use of expert systems to inform diagnosis, and the use of wearable data in assistance in treatment deployment and assessment.

# *Parenting Practices of the Newly US Resettled Families: A Cross-Cultural Comparison*

## Levin College of Public Affairs and Education

**Student Researcher:** Diana Schoder

**Faculty Advisors:** Grace H.C. Huang and Eddie T.C. Lam

## Abstract

**Introduction:** The United States admitted 31,797 refugees so far in 2023. Raising children in a new culture is challenging for refugee parents. As children's caretakers/models, parents' behaviors directly impact a child's development and future conduct. The purpose of this study was to compare parenting practices of newly resettled families who spoke Arabic, Swahili, and Ukrainian in the United States.

**Methods:** The 40-item English version of Revised Parenting Style and Practices Scale (R-PSPS) has four dimensions (Expectations, Autonomy, Discipline, and Parental Involvement) and was translated into Arabic, Swahili, and Ukrainian. Through SurveyMonkey, 61 useful surveys were collected: Arabic (31), Swahili (13), and Ukrainian (17). These participants were refugee and immigrant parents who had one or more children in K-12.

**Results:** No significant difference in those four dimensions of R-PSPS among people who spoke different languages, though people spoke Swahili had higher scores in all those dimensions than their counterparts. Significant gender differences were found in Expectation ($F$ = 4.742, $p$ = .033) and Autonomy ($F$ = 3.446, $p$ = .068). Mothers had higher expectations while allowed higher level of autonomy for their children than fathers.

**Discussion:** The non-significant among parents who speak Arabic, Swahili, and Ukrainian in parenting style and practices is probably because the sample size is too small to reject the null hypothesis (statistical power is too low). The results that mothers have higher expectations and allow higher level of autonomy for their children are consistent with previous studies (e.g., Johnson, 2016). Unlike other studies that include only mothers or fathers in their investigation (Capaldi et al., 2008; Choi et al., 2021; Flament et al., 2023; Johnson, 2016), the study stands out from others since it compares both mothers and fathers simultaneously and thus provides more insights in the findings.

# *Stabilizing Factors of Pickering Emulsions by Boron Nitride Nanosheets*

## Washkewicz College of Engineering

**Student Researcher:** Daniel V. Habean

**Faculty Advisor:** Geyou Ao

## Abstract

Pickering emulsions can be stabilized by 2D materials such as hexagonal boride nitride (hBN) nanosheets. This study investigates the relationship between sonication time, oil-water ratio and hBN concentration on the formation of stabilized emulsions. Findings indicate that emulsion stability is directly impacted by the concentration of hBN.

# *Sustainable Solutions for Waste Management - Fluid Dynamics Considerations in the Gasification of Household Recyclables*

## Washkewicz College of Engineering

**Student Researcher:** Rushi R. Viradiya

**Faculty Advisor:** Jorge E. Gatica

## Abstract

In this work, carbon and alumina catalyst supports are used to investigate the gasification of household waste materials such as polyethylene (PE), nylon, polyethylene terephthalate (PET), and cellulose. The experiment used reactor temperatures between 300 and 350 °C to evaluate the reaction kinetics and behavior of these materials at various speeds. The catalyst to substrate ratio was kept at 1:1, and gas chromatography was used to examine the product stream.

Results show that gasification has the potential to be a workable solution for treating typical home materials. Notably, the stability of the carbon and alumina catalysts was evident throughout the studies, which may have been caused by the equilibrium of the Sabatier reaction. The system, however, displayed unanticipated behavior at specific mixer speeds, emphasizing the need for precision control in gasification process optimization.

In addition, carbon generated as a byproduct of catalytic gasification shows promise as a dependable energy source. The study emphasizes how complicated the reaction kinetics are for gasifying municipal waste because there are numerous simultaneous reactions that must be considered.

In conclusion, this study sheds important light on the gasification of waste materials from homes, opening up a possible route for resource recovery and sustainable waste management. Future research should concentrate on improving the method for treating municipal waste applications, considering the complex interaction of reactions and control factors.

# *Stheno: Viral-like-Partical + Elastin-Like-Polypeptide*

## Washkewicz College of Engineering

**Student Researcher:** Mikala McCay

**Faculty Advisor:** Nolan Holland

## Abstract

What if medications could be delivered directly to the site of your body where they're needed the most? This is possible using nanoparticles that are decorated with compounds that interact with specific cells. This research is intended to create a new nanoparticle that can be decorated with targeting peptides. We have designed a virus-like particle (VLP) with attached elastin-like polypeptide (ELP) of different lengths. The VLP is a coat protein taken from Salmonella virus P22, a bacteriophage that infects Salmonella. ELPs are polypeptides with a repetitive sequence that make the nanoparticles temperature responsive. The thermo-responsive VLP+ELP becomes more soluble as the temperature gets colder. At higher temperatures they aggregate and come out of solution. This temperature-dependent aggregation allows the particles to be purified. The ELP also acts as a spacer which a targeting compound can be added to. Previously, two different lengths of ELP were added to the VLPs, 10 and 40 ELP repeats. For this work, we are preparing a VLP with an intermediate ELP length of 20 repeats.

# *2D Functional Materials for Lead Detection by Colorimetric Method*

## Washkewicz College of Engineering

**Student Researchers:** Aljoharah Alhobayshi and Obaid Khan

**Faculty Advisor:** Shaowei Yang

## Abstract

This study introduces a novel, eco-friendly approach for detecting lead in water sources with 2D functional materials by the colorimetric method. Leveraging the high concentration of functional groups available in 2D materials, we aim at achieving a simple yet highly sensitive lead detection mechanism capable of detecting concentrations down to the ppb level. This innovative procedure promises to be a cornerstone in efforts to safeguard our communities against the pervasive threat of water contamination, encapsulating science, and safety in a hue of shifting colors that signal the presence of lead with unprecedented precision and accessibility. The 2D material was characterized using Scanning Electron Microscopy for crystal morphology, Fourier Transform Infrared, and X-ray spectroscopy to detect the presence of amino acids in the structure and crystallinity respectively. Four concentration levels were used to demonstrate the color response of the 2D materials including 100,10,1 and 0.1 ppm. Apparent color response was observed to different lead concentrations. Overall, this study helped to produce a novel 2D materials that can be used to detect the lead amount in solutions at ppb levels.

# *Take a Break from Driving*

## Washkewicz College of Engineering

**Student Researchers:** Aflah Albaimani and Sean Armen

**Faculty Advisor:** Jacqueline Jenkins

## Abstract

A driving simulation study was conducted to test whether drivers who took a one-week break midway through training would perform better than those who did not take a break. The study was designed as a repeated measures, two-factor factorial. There were 6 trials of the same steering chase task. The steering chase task required the driver to turn the steering wheel to chase a target moving on the simulator screen. There were two groups of drivers: 8 participants who drove all 6 trials during their first visit; and 8 participants who drove trials 1 through 3 on their first visit and trials 4 through 6 one week later. For each trial, the percentage of time the target was successfully chased was recorded. The effect of the trials was statistically significant (p=0.0062) indicating that the performance improved over the 6 trials. The effect of the groups was not significant (p=0.1222). Since all participants achieved at least 90% accuracy in each trial, perhaps the steering chase task was too simple.

# *Effect of Freeze and Thaw on Structural Wood*

## Washkewicz College of Engineering

**Student Researchers:** Megan Stroescu, Luis Balmori, and Stephen Asare

**Faculty Advisor:** Josiah Owusu-Danquah

## Abstract

Structural wood in Northeast Ohio is susceptible to harsh environmental conditions such as varying freeze and thaw cycles throughout the course of a year. The aim of this research project is to assess the impact of freeze and thaw cycles on wood's load-bearing capacity through compression testing. For this purpose, a plethora of wood species were obtained from suppliers and subjected to controlled freeze-thaw cycles in a laboratory setting to replicate natural environmental conditions. Concurrently, another set of wood samples from the same source was kept under controlled conditions as a control group. The masses and frequencies of all the samples were taken prior to the testing and after the fact. After exposing the specimens to a predetermined number of cycles in the environmental chamber, compression tests were conducted to quantify the effect of freeze and thaw cycles on their load-bearing capacity. The mechanical properties were measured for all groups as a function of the number of cycles. The results indicated that **(i)** freeze and thaw cycles reduce the load-bearing capacity of structural wood significantly, **(ii)** the rate of strength reduction from cycle to cycle is dependent on the wood species, and **(iii)** for several wood species, compression yield strength remains almost constant for freeze and thaw cycle numbers between 40 and 60. By focusing on understanding the effect of freeze-thaw cycles, a prominent climatic phenomenon typical to this region, the present results will enable engineers to make judicious choices in regard to the design of reliable, durable, and safe infrastructure.

# *Quantum Neural Network for Cancer Detection*

## Washkewicz College of Engineering

**Student Researcher:** John Parker

**Faculty Advisor:** Sathish Kumar

## Abstract

Breast cancer is the most commonly occurring cancer, affecting approximately 13 percent of women in the United States. Early diagnosis and treatment are vital to improving chances of recovery for affected individuals. Recently, machine learning models, specifically convolutional neural networks have been employed to perform automated image analysis. The use of such models for microscopic analysis of breast tissues saves pathologists time in performing specialized analysis and greatly improves breast cancer detection accuracy. As quantum computing continues to evolve, machine learning researchers aim to harness it's power in hopes of faster and more accurate image classification. The aim of this research is to implement various quantum machine learning models to accurately identify breast cancer tissue images and to display a quantum advantage in the field of microscopy image classification. The models created and used in this research, a quantum support vector classifier (QVC), quanvolutional neural network (QNN), and quantum convolutional neural network (QCNN), were trained and tested on a dataset of 500 hematoxylin and eosin-stained images. The dataset images span across four equally represented classes: normal, benign, in situ carcinoma, and invasive carcinoma. We created, optimized, and measured the accuracy for the support vector classifier. For both neural network architectures used, we experimented with pre-existing classical CNN architectures. Quantum machine learning for image classification is still a growing field, sure to be evolved by future QCNN models. In the future, we plan to create and employ QCNN circuits from scratch and deploy them on near-term quantum computers rather than simulators.

# *Intrusion Detection Framework for Security Attacks in Software Defined Networking Environment*


## Washkewicz College of Engineering

**Student Researcher:** Carmen Garcia

**Faculty Advisor:** Sathish Kumar



## Abstract

Since the introduction of Software Defined Networking (SDN), our perspective on network strategies has changed. The rapid embrace of SDN has transformed our perception on the way networks are managed and deployed. However, it has also presented new challenges in the aspect of security. In this article, we present a comprehensive intrusion detection framework designed to address security attacks in SDN environments, with a focus on Distributed Denial of Service (DDoS) attacks. Our suggested framework uses the full potential of SDN's capabilities to monitor, analyze and detect the real-time network traffic on DDoS attack. Additionally, it utilizes the gathered data to create a DDoS dataset, which is employed for training and prediction through machine learning algorithms (ML).

The primary objective of this study is to offer an evaluation of the accuracy and an effective method for detecting DDoS, with the utilization of Mininet and the Ryu controller to simulate the network environment.



Keywords – SDN, ML, DDoS, Ryu, Logistic Regression, Naïve Bayes, SVM, Decision Tree, Random Forest, K-NN, ICMP, UDP, TCP-SYN, PCA.

# *Performance Evaluation of Pre-Trained Encoders for Microscopy Image Tasks*

## Washkewicz College of Engineering

**Student Researcher:** Joshua Wiess

**Faculty Advisor:** Sathish Kumar

## Abstract

One of the most important factors that exist in creating an effective convolutional neural network is the amount of data that is available to train the model on. Despite most industries having plenty of data, there typically exist laws and regulations regarding how that data can be utilized and shared which inhibits the potential of the models. Exploring well-known model architectures and training approaches allows us to determine how we can create the most effective models possible within the limited scope of our dataset. We chose to explore models such as Resnet50, Squeeze-and-Excite Resnet50, DenseNet-121, Inception-V3, and Inception-ResNet-V2 which have all been known to be quite successful in image classification. We then combined these models with various training approaches such as transfer learning and training from scratch. In our implementation of transfer learning, we utilized the parameters from a version of the same model pretrained on the ImageNet 2012 dataset, and we did one test with the whole model being trainable as well as one with only the last layer being trainable. These three approaches were applied to each model and the results of all the models and approaches were compared. In all of our models, transfer learning with the whole model being trainable produced the best results with Inception-ResNet-V2 achieving the highest accuracy of 96.11%. It is interesting to note that the ImageNet 2012 dataset had no similarities to our microscopy dataset, but it still greatly assisted with our classification task.

# *Introduction to Zero Knowledge Proofs*

## Washkewicz College of Engineering

**Student Researcher:** Connor Van Etten

**Faculty Advisor:** Haodong Wang

## Abstract

In this study, we explore the field of Zero-Knowledge Proofs (ZKP) that allows one party, the prover, to convince another party, the verifier, that a specific statement is true, without revealing any additional information about the statement. ZKP has wide applications in privacy preserving, security, and trust related industries. In particular, ZKP receives much attention in crypto-currency applications. Our work covers the introduction of ZKP and its mathematical foundation, which requires asymmetric encryption in the discrete logarithm field to realize the ZKP operations. For practical purposes, we explore our own ZKP protocol implementation by using two different programming languages: Python and C. The Python implementation serves as the proof of concept, and the C implementation showcases the computational latency of the ZKP operations. Our future study includes the goal to optimize our implementation on a GPU-assisted computing system so that the computational latency can be significantly reduced for the efficiency purposes.

# *Signal Localization with Unmanned Aircraft System*

## Washkewicz College of Engineering

**Student Researcher:** Domenic M. Ticchione

**Faculty Advisor:** Ye Zhu

## Abstract

By measuring signal values at various points, it becomes possible to estimate the relative location of the source of the signal. Our aim is to implement an unmanned aircraft into this process. Specifically, we seek to create a flight program for this unmanned aircraft which will cause it to automatically travel to a sequence of coordinates to better collect the signal strength data necessary for the signal localization process. For this, we used a DJI Mini 3 Pro aircraft and modified a sample program which includes a copy of DJI's Android software development kit. The program is modified such that the Return-To-Home (RTH) function, which would by default cause to aircraft to fly back to its takeoff location, now flies to one of three equidistant points surrounding the aircraft's takeoff location each time it is initiated. By affixing a smartphone to the aircraft, we can measure the strength of wireless signals at each of the desired points and later use this to approximate the relative location of the signal's source. Multiple tests are done with the aircraft flown to various altitudes and horizontal distances to get a better sense of the relationship between distance and signal strength.

# *Design and Performance Analysis of Underwater Wireless Optical Communications*

## Washkewicz College of Engineering

**Student Researcher:** Garrett Pazey

**Faculty Advisor:** Mehdi Rahmati

**Abstract**

Having an effective wireless communication system underwater is crucial to the success of many different types of underwater exploration. In the past, acoustic waves have been the most reliable way to send messages underwater. With modern optical technology, underwater wireless optical communication (UWOC) has become a much better and more efficient way to communicate underwater. This summer, we researched different modulation types for UWOC such as on-off keying (OOK) and orthogonal frequency division multiplexing (OFDM). We developed a working OOK system to conduct performance analysis to maximize the effectiveness of our system. We found data such as the best color of LED and how the system performs in clear vs murky water. Our underwater system proved the potential for this area of study and with the implementation of our OFDM code and a laser diode transmitter, the system will reach farther distances and transmit at a very high data rate. Experimental results show that the system works well and is prepared to be used with off-the-shelf microcontrollers to shrink the system for field use in the futuristic underwater Internet of Things.

# *Rapid Detection of Methicillin Resistant Staphylococcus Aureus*

## Washkewicz College of Engineering

**Student Researcher:** Genevieve Mann

**Faculty Advisor:** Siu-Tung Yau

**Abstract**

Antibiotic resistance in bacteria is a current and growing problem. A large contributor to this problem is the inability of hospitals to make fast diagnoses. The time it takes a hospital to diagnose these infections is anywhere from 7-24 hours, using methods like PCR and ELISA. During this time patients are given broad spectrum antibiotics, which do nothing. As well as this, overuse of broad-spectrum antibiotics gives rise to more antibiotic resistant strains of bacteria. Using a modified three-electrode electrochemical cell, it is possible to detect bacteria much faster than conventional methods. With this new way of testing for bacteria, results can be obtained within two hours upon receiving the sample. The sample is placed within a sandwich structure on the working electrode. The structure is made up of five layers. The first two provide a base, while the final three are specialized depending on the suspected bacteria being tested. The sample is placed on top of a capture antibody, then a detection antibody is placed on top of the sample after some incubation. The sample is incubated again, then is tested for around 30 minutes. The testing is an electrochemical immunoassay with an amplified electrical signal. The amplification combined with the bacteria-antibody immune reaction, allows for high detection sensitivity, into single digit CFU/mL. This runs for 17 trials, which are then used to generate a graph which is used to interpret the results. The entire process takes around two hours. Currently, the prototype is able to test for E. coli, MSSA, and MRSA. The platform is showing promising results with clinical samples obtained from University Hospitals. This is a low cost, time effective way to test for bacterial infections that can test for both a specific species and antibiotic resistance.

# *Develop a Virtual Environment for Learning Community-Based Cybersecurity Training*

## Washkewicz College of Engineering

**Student Researcher:** Edward Cabrera

**Faculty Advisor:** Wenbing Zhao

**Abstract**

The mobile application aim was to develop a training environment to educate individuals by providing materials such case studies and self-testing component. The subject of the material is cybersecurity, or more specifically, social engineering attacks that individuals encounter and fall victim to daily. These materials will hopefully educate and raise awareness of these attacks by defining what they are, how to identify them, and practicing countermeasures. The app has two types of accounts: user account and administrator account. A user may register and login to a user account to learn the modules provided on social-engineering based cyberattacks, and take quizzes to check the learning outcomes. The administrator may login to oversee the user progress, and collect analytical data on the amount of time taken by each user.

# *Studying the Process-Microstructure-Properties Relationship of M2 Tool Steel Processed by Binder Jetting*


## Washkewicz College of Engineering

**Student Researchers:** Stephen Omeike and Amit Choudhari

**Faculty Advisor:** Tushar Borkar


## Abstract

AISI M2 tool steel is widely used in cutting applications requiring high operating temperatures and long material life, such as heavy cutting and high-speed machining. The steel is typically alloyed with tungsten, molybdenum, chromium, and vanadium to enhance its properties. Binder jetting is a promising additive manufacturing technique capable of producing complex shapes with minimal residual stresses and isotropic properties. However, the processing-structure-property relationships of M2 tool steel produced via binder jetting remain largely unexplored. Therefore, this study aims to investigate the effects of printing parameters and sintering conditions on the microstructure and mechanical properties of binder jetted M2 tool steel. In this study, two powder sizes (~ 5 and 10 $\mu m$) were used, and sintering was performed at varying temperatures (1270, 1280, and 1300°C) and durations (60 and 120 minutes). Microstructure, mechanical, and wear properties of binder jet processed M2 tool steel will be discussed in the poster.

# *Experimental Investigation on Effects of Boron Nitride Reinforcements in Titanium Matrix Composites*


## Washkewicz College of Engineering

**Student Researchers:** Rex Boyer, Satyavan Digole, and Smriti Bohara

**Faculty Advisors:** Chandra Kothapalli and Tushar Borkar



## Abstract

Titanium matrix composites (TMCs) have been a significant area of research due to their usefulness in high performance applications. TMCs are lightweight materials that feature high specific strength, exceptional chemical resistance, and admirable biocompatibility. Their high specific strength and stiffness are greater than other commonly used base materials, such as steel and nickel. These attractive mechanical properties have been useful in aerospace, military, and biomedical industries. The goal of this research is to examine the functionality of various proportions of hexagonal boron nitride (h-BN) reinforcements and experimental parameters to create Ti-hBN TMCs featuring network-woven TiB nanowires in a core-shell structured Ti matrix. The addition of the h-BN should improve the wear resistance and strength of the TMCs without compromising biocompatibility. The experimental parameters should be optimized to generate homogenously dispersed TiB nanowires throughout the Ti matrix along with high relative densification. The fabrication of the TMCs will utilize planetary ball milling (PBM) to create homogenous powder mixtures and spark plasma sintering (SPS) for rapid consolidation of the powders. X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS) will be used to analyze the various phase formations and homogenous dispersion of the TiB nanowires in the sintered samples. Compression, Vickers hardness, and tribological analysis testing will be used to examine their mechanical properties. Cell viability, cell attachment, and toxicity testing will then be used to test the biocompatibility of the TMCs.

# *Hybrid Wind-Solar Energy Powered EV Charging Station*


## Washkewicz College of Engineering

**Student Researcher:** Ali Almusalli

**Faculty Advisor:** Navid Goudarzi



## Abstract

This project explores the development of a hybrid charging station in Cleveland, Ohio, which utilizes both wind and solar energy to charge electric vehicles. The primary objective is to assess the feasibility of a charging station that harnesses the advantages of both renewable energy sources. To achieve this, we collect data on wind speed and solar irradiance in Cleveland to gauge the potential energy generation. Through calculations, we aim to ascertain the station's energy requirements for daily operation and its capacity to effectively charge electric cars within the specified timeframe.

# *Material Characterization of Natural Hydrogels for the Development of Nerve Scaffolds in Tissue Regeneration Applications*

## Washkewicz College of Engineering

**Student Researchers:** Kylie Schmitz, Colin Overy, Aja Anh Phan,* and Kaitlyn Schroyer

**Faculty Advisor:** Liqun Ning

## Abstract

Peripheral nerve injuries are common among individuals involved in traffic accidents, natural disasters, military activity, and other injurious situations. Cell death near the injury site and limitations regarding precursor cells lead to difficulties in regeneration of neural tissue. Tissue engineering has opened doors toward the fabrication of synthetic scaffolds for neural regeneration. Natural and synthetic hydrogels have piqued the interest of several tissue engineers due to their tunability, biocompatibility, and structural stability. The properties of materials must be further studied to understand their impact on cell performance. Experimental and computational simulation data can provide a basis for understanding the mechanical and structural properties of materials. Understanding the characteristics of bio-printed and crosslinked hydrogels is the first step toward printing scaffolds that mimic biological tissues.

In this work, four natural hydrogels were prepared including 2% alginate, 2% alginate + 5% gelatin, 10% gelatin methacryloyl (gel-MA), and 10% gel-MA + 5% gelatin, all measured as weight/volume. Nerve scaffolds with channels were fabricated from these hydrogels using embedded 3D bioprinting and crosslinking techniques. Topographical features were studied via scanning electron microscopy (SEM) and mechanical properties were measured using static uniaxial compression testing. Finite element analysis was used to predict shear strain based on data from compression testing, then the experimental and computational results were compared. Hydrogel stiffness after crosslinking, fluid absorption, and pore formation appeared to be determining factors for material strength. Further understanding the properties of bioprinted hydrogels will provide a foundation for advancements in tissue engineering for regenerative medicine. Future work should explore cell performance as a function of material properties with the goal of eventual clinical applications.

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