UNDERGRADUATE

RESEARCH SHOWCASE

SUMMER 2022

August 2nd

Griffis Hall

MISSISSIPPI STATE UNIVERSITY™
JUDY AND BOBBY SHACKOULS
HONORS COLLEGE

CONTENTS

WELCOME

The Shackouls Honors College is pleased to host the Summer 2022 Undergraduate Research Showcase. Thank you for attending.

This showcase promotes undergraduate participation and learning in both research and creative endeavors. Additionally, it supports students in demonstrating their interest and dedication to those activities. Participating in undergraduate research is an exciting way for students to complement their academic studies and preparation, paving the way for future intellectual work and exploration.

This event is not possible without the time, effort, and assistance of our dedicated faculty mentors. The student work presented here represents many hours of mentoring students in their research, planning, and analysis. Many faculty, post-doctoral assistants, and graduate students have also volunteered their time and expertise to serve as evaluators and commenters to offer students valuable and constructive feedback. So, thank you to all of them!

Students have entered in one of four categories: Humanities and Arts, Biological Sciences and Engineering, Physical Sciences and Engineering, or Social Sciences. Please visit, discuss, and engage with students. There are comment cards available for you to complete and share your feedback with students about their work.

We are delighted that you have joined us today to peruse the accomplishments of our young researchers. We hope you learn much from the array of interesting projects. Enjoy!

Sincerely,

Anastasia D. Elder, Ph.D.
Director of Undergraduate Research & Creative Discovery
Associate Dean, Shackouls Honors College

Mississippi State University's Undergraduate Research Showcase
Summer 2022 Schedule

Tuesday, August 2

Poster Session: Biological Sciences and Engineering (BSE), Physical Sciences and Engineering (PSE), Social Sciences (SS)		
Time	**Event**	**Location**
1:00 p.m. - 1:30 p.m.	Project Check In: BSE, PSE, SS	Front Entrance, First Floor, Griffis Hall
1:30 p.m. - 2:00 p.m.	Project Visiting Time for Student Presenters	All Floors, Griffis Hall
2:00 p.m. - 3:30 p.m.	Poster Session	First and Second Floor Lobbies, Griffis Hall (BSE #1-37) Third Floor Lobby, Griffis Hall (PSE #38-71) C401, Fourth Floor, Griffis Hall (PSE #72-80 and SS #81-89)
3:30 p.m.	Poster Session Concludes	

Oral Presentation Session: Humanities and Arts (HA)		
Time	**Event**	**Location**
1:45 p.m.	Project Check In: HA	Front Entrance, First Floor, Griffis Hall
2:00 p.m.	Welcome Message	C407, Fourth Floor, Griffis Hall
2:05 p.m. - 3:00 p.m.	Oral Presentation Session *(Schedule below)*	
3:00 p.m.	Closing Remarks	

Humanities and Arts (Oral Presentations) Session

Tuesday, August 2 - C407, Fourth Floor, Griffis Hall

These are 10 minute talks. One or two questions are allowed but time needs to be left for the next speaker to set up.

2:00 p.m. Welcome Message

2:05 p.m. Allyson Espy (90): Exploring Girlhood through Late Meiji and Taisho Period Literature

2:25 p.m. Aliyah Necaise (91): The Utilization of the Arts in Teaching Language to Polish and Ukrainian Students

2:45 p.m. Mary Sanders (92): Representing subjects of scientific study through artistic expression. An effort to bridge the artistic and scientific community at MSU

3:00 p.m. Closing Remarks

PROJECT MAP

FIRST FLOOR

PROJECT CATEGORY MAP

Floors 1 & 2
Biological Sciences & Engineering

Floor 3
Physical Sciences & Engineering

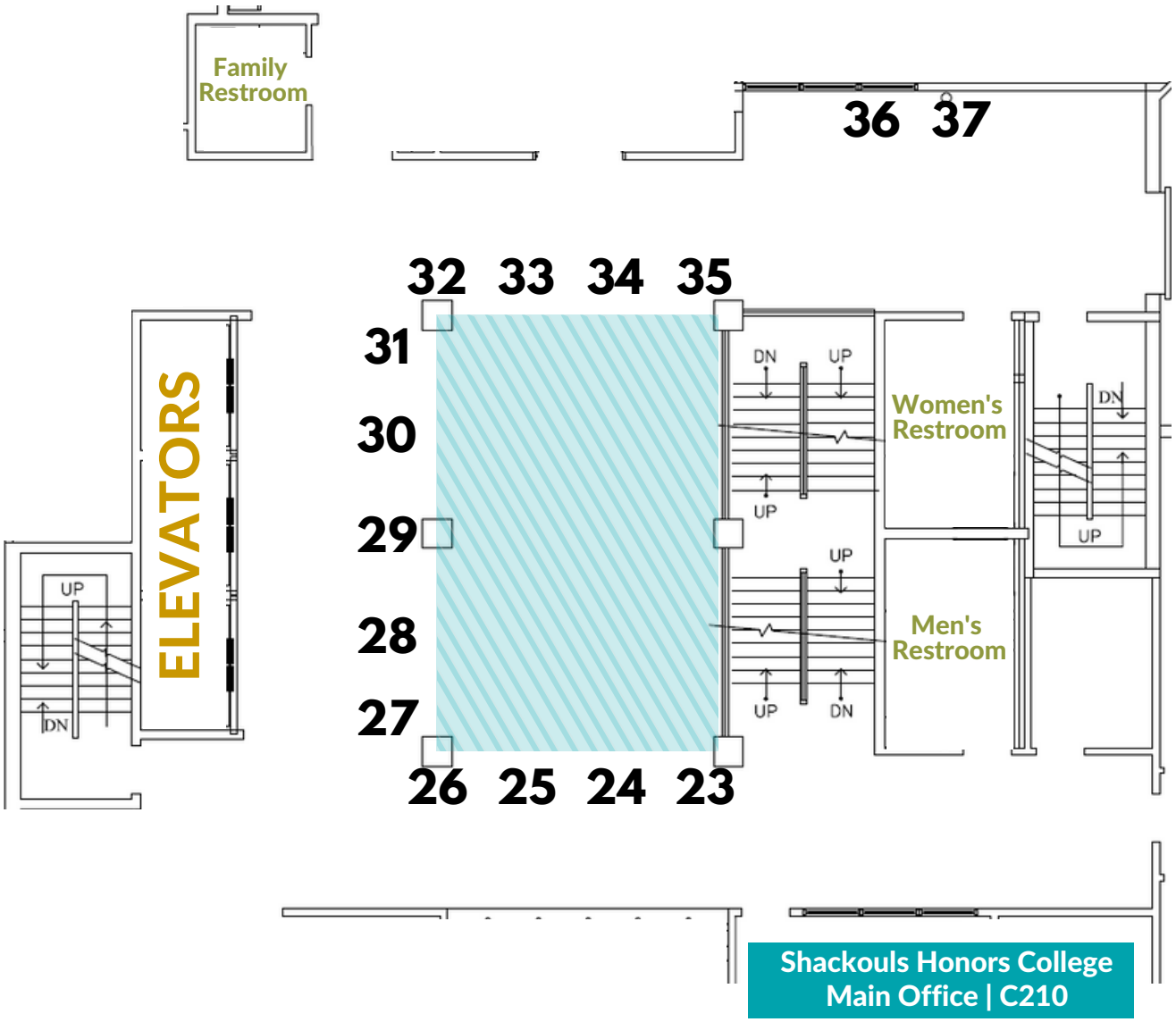
Floor 4 | C401
Physical Sciences & Engineering
Social Sciences

Floor 4 | C407
Humanities & Arts Presentations

GRIFFIS HALL

SECOND FLOOR

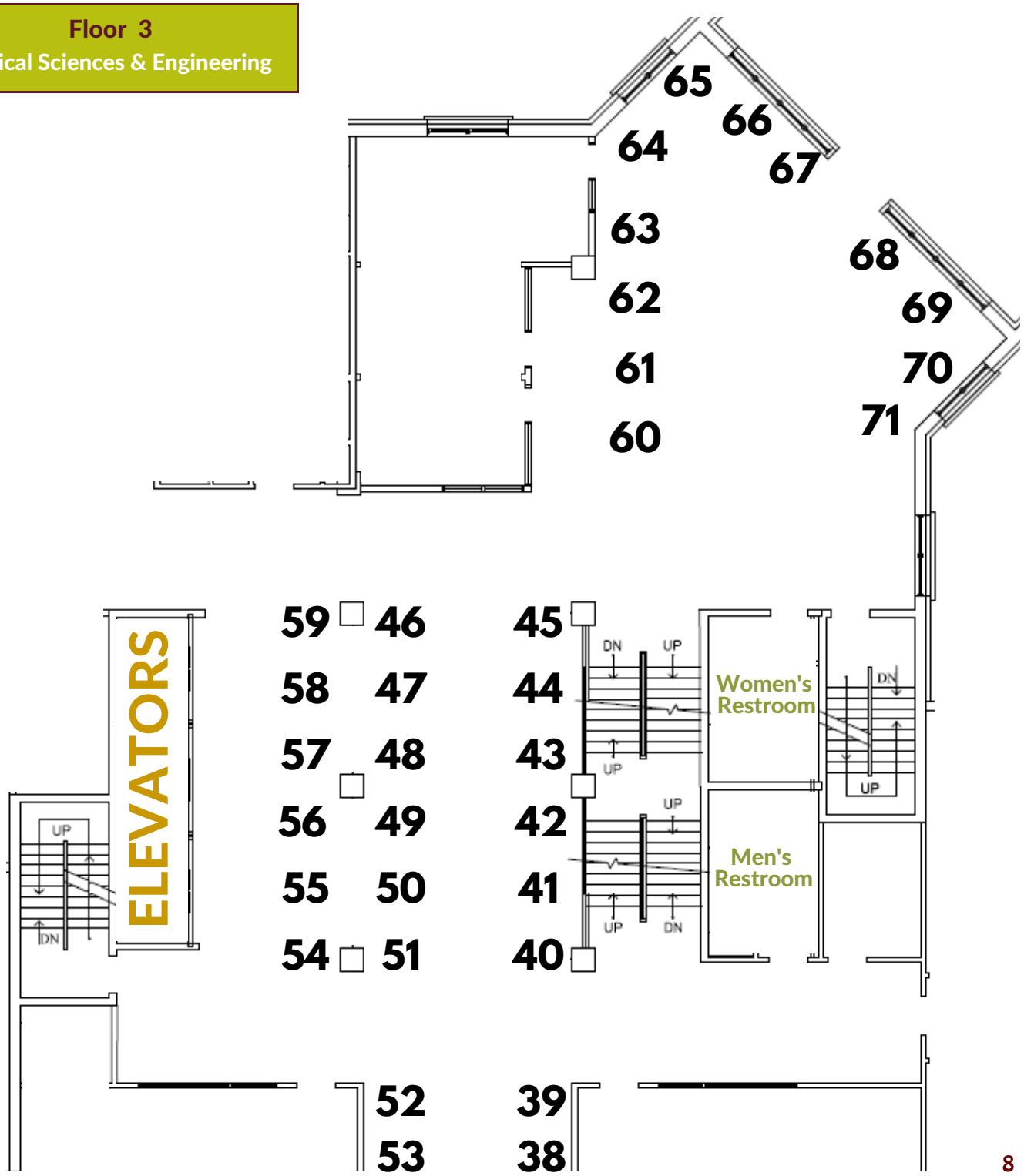
Floor 2
Biological Sciences & Engineering



PROJECT MAP

THIRD FLOOR

Floor 3
Physical Sciences & Engineering

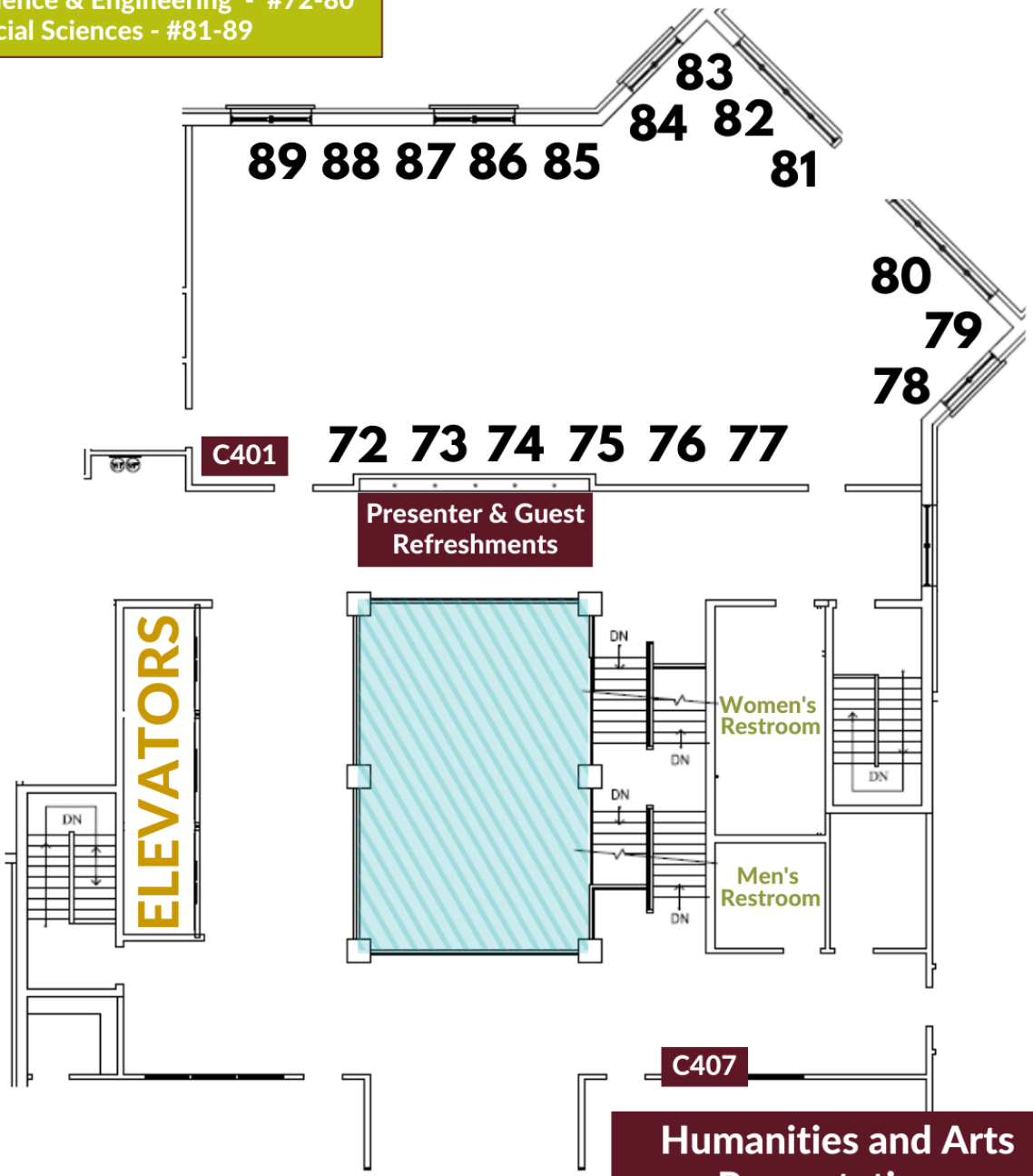


GRIFFIS HALL

FOURTH FLOOR

Floor 4 | C401

Physical Science & Engineering - #72-80
Social Sciences - #81-89



Humanities and Arts Presentations:

2:00 p.m. - Welcome Message
2:05 p.m. - #90
2:25 p.m. - #91
2:45 p.m. - #92

81
Name: Alvarez Rios, Laura
Major: Psychology
Faculty Advisor Name, Affiliation: Hilary L. DeShong, Psychology
Project Category: Social Sciences
Co-Author(s): Karen Kelley, Courtney K. Mason

Examining Life Satisfaction as a Moderator of the Relation between Borderline Personality Disorder and Alcohol Use

Borderline personality disorder (BPD) is an impairing mental health disorder characterized by significant emotion dysregulation difficulties, engagement in impulsive behaviors, and interpersonal difficulties (American Psychiatric Association [APA], 2013). Alcohol use disorder (AUD) refers to a maladaptive pattern of drinking behavior and difficulties controlling one's alcohol use despite experiencing adverse consequences (APA, 2013). Symptoms of BPD and AUD are highly comorbid, and people with heightened BPD symptoms appear to be at an increased risk for displaying co-occurring AUD symptoms (Trull et al., 2018). Additional research is needed to understand how certain cognitive evaluations, such as a person's perceived life satisfaction (LS), contribute to the associations between BPD and AUD symptoms. The purpose of this study was to examine how life satisfaction moderates the relation between BPD and AUD symptoms. It was hypothesized that lower levels of LS would result in a stronger relationship between BPD and AUD symptoms whereas higher levels of LS would result in a weaker relationship between these two constructs. Data were collected from a sample of 535 college students and 308 community members via Amazon Mechanical Turk (MTurk). Participants completed online survey measures assessing BPD symptoms, substance use, and life satisfaction. Two moderation analyses for each sample were conducted via SPSS AMOS 28.0. Results indicated that heightened BPD symptoms were associated with greater AUD symptoms for both samples. Life satisfaction was not significantly associated with AUD symptoms, nor did differences in life satisfaction moderate the relation between BPD and AUD symptoms. These results suggest that life satisfaction may not be a salient cognitive process associated with AUD symptoms after accounting for BPD symptoms. Future research would benefit from examining other cognitive appraisals and processes to identify risk factors contributing to increased AUD symptoms among those with BPD symptoms.

38
Name: Anderson, Joseph
Major: Chemistry
Home Institution (Other than MSU): Delta State University
Faculty Advisor Name, Affiliation: Charles E Webster, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Garrett Wells
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Determining Blue Light Emission in Platinum CCC-N-Heterocyclic Carbene Pincer Complexes
New molecular architectures for NHC pincer complexes have been researched to impart desired physical and chemical properties, such as emission of blue light (the industry standard for blue light being 465 nm wavelength). Using these ligand architectures with transitional metals, we can develop a new material for use as a blue light emitter in OLED screens. In our research, we are designing molecules based on these new architectures to investigate what structural changes lead to alterations in the absorption and emission wavelengths. Our work has proceeded through use of the modeling program, Cerius^2 to build the initial molecular structures to be optimized and a suite of programs called Gaussian 16 to perform the geometry optimizations and compute electronic transitions to simulate absorption and emission spectra. We have optimized ~1/3 of the 400 unique structures and have completed their emission calculations. Our goal is to provide experimentalists with synthetic targets for molecules that emit at 465 nm.

39
Name: Arizmendi Almaraz, Alan
Major: Chemical Engineering
Home Institution (Other than MSU): Iowa State University
Faculty Advisor Name, Affiliation: Neeraj Rai, Chemical Engineering
Project Category: Physical Sciences and Engineering
Co-Author(s): Dr. Abdus Sabuj, Chinmoy Saha

Quantum Mechanics Calculations Predict Stability and Ground State of Polymers with Diradical Characteristics

Polymers with diradical character were first investigated when Aleksei Tchichibabin first synthesized Chichibabin's Hydrocarbon in 1924. Given their open shell nature, diradicals are of interest in the optoelectronic field as good candidates for semi-conductors; however, this means that many are intermediate substances and can be unstable at STP conditions. Advancements since the early 20th century have made it possible to identify and even categorize a variety of stable diradical polymers [1]. Conjugated polymers (CPs) are one such group as electron delocalization through overlapping pi orbitals increases overall stability of the diradical form of these polymers [2]. Along with diradicals, computational methods in research have advanced greatly in the past years and are a good complement to experimental methods. This has allowed for the use of quantum mechanical computations to predict optoelectronic and physical properties of CPs with high accuracy. Here, we implement these methods using the software Gaussian16 to gather data of different properties of an existing polymer (CPDT-TQ) with known diradical character [3]. The data gathered on energy, triplet-singlet gap, and other properties will be used in improving the accuracy and reliability of using these same methods with novel polymers. As a preliminary step, calculations were done on an oxygen molecule which revealed a y-index of 0.997 and a more stable triplet state. The y-index quantifies the diradical character of a molecule with a y-index of 1 indicating a pure diradical. This result agrees with theory as oxygen is known to be a diradical with a triplet ground state [4]. This allows us to be confident in the resulting calculations for the CPDT-TQ polymer and its modified versions where stability seems to increase with polymer length.

01
Name: Barker, Dallis
Major: Biological Sciences
Home Institution (Other than MSU): Tougaloo College
Faculty Advisor Name, Affiliation: Gary Ervin, Biological Sciences
Project Category: Biological Sciences and Engineering
Co-Author(s): Andy Sample, Gray Turnage
REU/Research Program: INFEWS Program

Effects of density and species interactions on *Juncus effusus* and *Schoenoplectus tabernaemontani* growth and Biomass production

Juncus effusus (common rush) and *Schoenoplectus tabernaemontani* (Softstem bulrush) are both native wetland species in the United States, have similar growth forms, and exhibit similar phenological patterns. Both are desirable species for wetland conservation and restoration purposes; however, little is known about their competitive abilities. Competition is a type of interaction that can result in a negative outcome on plant growth caused by neighboring individuals which limit resources like nutrients, water, and sunlight which are needed for survival. The purpose of this study was to quantify intraspecific and interspecific competition between *J. effusus* and *S. tabernaemontani* to understand whether and how planting density affects competition between these species. We hypothesized that species interaction and density would negatively impact plant growth, with *Juncus effusus*, the smaller of the two species, experiencing greater negative effects. In order to test this, we established mesocosms with both species grown alone and together at varying densities and monitored growth (culm density, fruiting and/or flowering and height) over a 5-week period. Plant biomass was harvested at the end of the 5-week study. The effects of plant density and species interaction on plant performance will be assessed by using regression analysis to compare growth metrics, and interaction intensity will be assessed by comparing growth metric log response ratios. This research will allow aquatic resource managers, regulatory agencies, and other researchers to further understand how these native wetland species compete with one another. Understanding these wetland species can improve conservation and restoration efforts.

02
Name: Barnes, Daylan
Major: Forestry
Home Institution (Other than MSU): Alcorn State University
Faculty Advisor Name, Affiliation: C. Elizabeth Stokes, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
Co-Author(s): Sarah Fullerton, Gabrielly d.s. Bobadilha, Elizabeth d.s. Stokes
REU/Research Program: USDA-REEU

The Fight on fungus

Treated wood is often left to endure destructive elements and species such as white-rot and brown-rot fungi. In this study, we utilized the Standard developed by AWPA's Technical Committees (E-10) to evaluate the effectiveness of wood protectants against brown-rot fungus. The method used throughout the study for this evaluation is soil/ block testing. Identical containers are filled with even amounts of sterilized soil and water, an aspen wood feeder strip, and white-rot fungus covered agar to develop the optimal environment for the fungus to grow. Treated cubes are placed in these environments after sufficient fungus growth has taken place (10-14 days). Weight of test blocks and visual ratings will be assessed following two weeks of exposure in a temperature-controlled chamber. Visual ratings will be assigned based on the standard rating scale in AWPA E-10. Results will be used to determine resistance to wood decay fungi imparted by treatments. Subsequent studies will introduce treatments to a greater number of fungi species over a longer duration.

40
Name: Bayarsaikhan, Delgermurun
Major: Software Engineering
Faculty Advisor Name, Affiliation: Gombojav Ariunbold, Physics & Astronomy
Project Category: Physical Sciences and Engineering
Co-Author(s): Alaa Chriat

Examining the progress on development of quadcopter technology

An unmanned aerial vehicle, also commonly known as a drone, is an aircraft that is designed to fly without the help of any person on board. As the study in the field progressed, a sub-genre of UAV, the rotary-wing aircraft has become particularly well known in fields such as photography, and precision agriculture. Among the multitude of rotary-wing aircrafts, our research was specifically conducted on quadcopters to further understand the intricate details of how a quadcopter works. With the help of the mpu9250's 3-axis gyroscope, 3-axis accelerometer, and 3-axis magnetometer onboard we plan on collecting and comparing flight quality results to develop a stable, and dynamic quadcopter model.

41
Name: Birke, Josh
Major: Chemical Engineering
Home Institution (Other than MSU): Southeast Missouri State University
Faculty Advisor Name, Affiliation: David Wipf, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Raymond Femi Awoyemi, Hari Giri, Colleen N. Scott

Phenothiazine-based polyaniline derivatives for corrosion protection of mild steel

Over the years, the conducting polymer, polyaniline (PANI), has been of great interest to researchers. Due to its environmental stability and mechanical and electrical properties, PANI has attracted research interest, especially in corrosion prevention and other applications. In corrosion protection applications, the redox properties of these types of polymers is of key importance. However, limitations arise due to poor solubility of PANI in common organic solvents and its electrochemical instability. In this work, we investigate the use of phenothiazine—a new class of polyaniline derivative—as a corrosion-resistant coating. We have copolymerized phenothiazine with PANI derivatives, which has improved solubility and electrochemical stability compared to PANI. In this study, we report the synthesis via Buchwald/Hartwig reactions phenothiazine polymers (long and short-alkylated polyaniline derivatives polymers) that were copolymerized with derivatives of *p*-phenylenediamine PPDA group (1,4-phenylenediamine; 2,5-dimethyl-1,4-phenylenediamine; and 2,3,5,6-tetramethyl-1,4-phenylenediamine). These were examined for the surface morphology and their corrosion protection as barrier coatings in comparison with poly(10-(2-hexyldecyl)-phenothiazine-3,7-diyl-*alt*-2,5-dimethyl-*p*-phenyledamine coatings. The corrosion protection properties of these polymers as coatings on steel were examined in 3.5 wt% NaCl solution using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS). This study demonstrates that phenothiazine-based polyaniline derivative polymers provide an excellent protective barrier against corrosion. The use of phenothiazine-based PANI can lead to new types of corrosion-resistant coatings.

03
Name: Bock, Kaitlyn
Home Institution (Other than MSU): East Mississippi Community College
Faculty Advisor Name, Affiliation: Justin Thornton, Biological Sciences
Project Category: Biological Sciences and Engineering
Co-Author(s): Jordan Coggins

Investigating links between Metabolism and Antibiotic Resistance in *Streptococcus Pneumoniae*

Streptococcus pneumoniae (pneumococcus) is a Gram-positive bacterium that colonizes the human nasopharynx asymptomatically and is responsible for invasive diseases including pneumonia, bacteremia, and meningitis. Pneumococcus has exhibited increasing resistance to antibiotics and finding new ways to treat infections is essential. However, it is not well-characterized how nutrient transport affects the uptake of antibiotics. We hypothesize that sugar utilization pathways impact the susceptibility of antibiotics. Identifying links between metabolism and antibiotic uptake will allow for the design of therapeutics which may enhance the effectiveness of current antibiotics. Preliminary data indicates a link between glycogen/maltose utilization and azithromycin sensitivity. We are creating marker-less deletion mutants for genes encoding SpuA, MalX, and MalT, which contribute to maltose and maltodextrin metabolism, to further our investigation of azithromycin resistance. Wild type and deletion mutants will be screened for susceptibility to azithromycin and related antibiotics to determine the contribution of individual proteins to susceptibility. Future studies will investigate using non-metabolizable small molecules to stimulate antibiotics uptake. Overall, the results of our research are significant for populations at risk for contracting pneumococcal infections and will salvage the use of current antibiotics to treat resistant pathogens.

04
Name: Boyd, Jonathan
Major: Biological Sciences
Home Institution (Other than MSU): Alcorn State University
Faculty Advisor Name, Affiliation: Mostafa Mohammadabadi, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
Co-Author(s): Dr. Street
REU/Research Program: USDA-REEU

Development of Bio-based Filament for 3D Printing

Background: 3D printing has attracted significant attention, from academic researchers and entrepreneurs to high school students. Instead of shaping and object using previous methods such as forging, machining, molding, and pressing, material is added layer by layer to create the final geometry. Unlike having significant advancements and development of mature 3D printing processes, research and development are still ongoing. Polymers and plastic based substances are mainly used in 3d printing in the form of filament. In this study, polypropylene (PP), polylactic acid (PLA), and a saw dust mixture of these polymers were used to make filaments. PP and PLA have different properties that can contribute to the differences in their strength and durability. Hopefully, adding the saw dust to the PP and PLA will create a stronger bio-based polymer.

Methods: A vertical single-auger extruder having five heating zones was used to make filaments with standard diameter of 1.75 mm using PP, PLA, and a mixture of these polymers and saw dust. To evaluate the mechanical properties of developed filaments and explore the effect of saw dust, filaments were submitted to tensile test to determine their stiffness and strength.

Discussion: Infusing bio-based products with the currently used polymers should increase the quality of the filaments. Such filaments result in production of bio-based, biodegradable, and renewable products. With higher quality filaments, stronger and more durable products will be easier to make.

05
Name: Bradley, Benjamin
Home Institution (Other than MSU): Auburn University
Faculty Advisor Name, Affiliation: Frank Owens, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
Co-Author(s): Brunela Pollastrelli Rodrigues, Alex C. Wiedenhoeft
REU/Research Program: USDA-REEU

The Effect of Surface Preparation on the Accuracy of Computer Vision Wood Identification Systems

While computer vision is increasingly becoming a tool of interest for identifying wood to combat illegal logging, recent research has raised questions about the suitability of trained models for real-world applications. One important consideration is how the quality of surface preparation affects the performance of models trained on “perfect” images to identify wood specimens. In the field, quality surface preparation is limited compared to laboratory-prepared specimens. The purpose of this study is to evaluate the performance of a previously published model when tested against images of lower-quality surface preparation. The model used for this study was trained and tested using images of wood samples with optimal surface preparation captured by the XyloTron device. To perform this study, wood samples from PACw Xylarium from Mississippi State University will be prepared in a range of grit levels, imaged, and tested to check for decreases in accuracy. It is expected that the performance of the model will decrease as soon as the model is unable to capture anatomical feature patterns. This study will provide practical insight into the performance of laboratory-developed models in real-world applications such as in the field and help to inform a minimum specimen preparation protocol for field deployment.

06
Name: Brode, Madison
Major: Biological Sciences
Faculty Advisor Name, Affiliation: Kristine Evans, Wildlife, Fisheries, and Aquaculture
Project Category: Biological Sciences and Engineering
REU/Research Program: Shackouls Honors College Research Fellowship

The Impact of Anthropogenic Noise on Avian Social Learning

The use of auditory and visual information to evade predators, detect prey, and communicate with others is crucial for the success of many species. However, it has been increasingly observed that anthropogenic noise has the ability to interfere with the transfer and reception of this type of information. While there is a large body of literature documenting how noise impacts the processing of auditory information in animals due to either masking or distraction, how excess noise affects the processing of visual information through cross-sensory interference is not well understood. For this project, we are investigating the impact of anthropogenic noise on the social learning abilities of a captive population of wild-caught European starlings (Sturnus vulgaris), a gregarious species which has been shown to use social information when learning in novel environments, using a randomized controlled experimental framework. A randomly selected group of demonstrator birds will be trained to complete a simple foraging puzzle. The foraging puzzle as well as video recordings of successful demonstrations will be presented to naïve conspecifics in either a control group or experimental noise group. If the visual-processing abilities of European starlings is affected by cross-sensory interference from anthropogenic noise, then individuals exposed to disruptive noise during the trial will be less successful at completing the task than conspecifics tested in a setting without added noise. Disruptions of the information transfer between individuals from anthropogenic noise has potential biological consequences if the ability to acquire resources or respond to indicators of risk from conspecifics are hindered. Therefore, this study will assist in providing crucial knowledge in regards to how noise disturbance may alter the abilities of individuals to successfully interact with their surroundings and whether or not noise should be an important consideration in mitigating the negative effects of human-dominated landscapes on ecosystems.

42
Name: Brooks, Kelsey
Major: Chemistry
Home Institution (Other than MSU): Tuskegee University
Faculty Advisor Name, Affiliation: Todd Mlsna, Chemistry; Tim Schauwecker, Landscape Architecture
Project Category: Physical Sciences and Engineering
Co-Author(s): Prashan Rodrigo
REU/Research Program: INFEWS

Optimization of Phosphate Removal In Stormwater Run-off from Layered-Double Hydroxide Modified Douglas fir Biochar

Rainwater collects pollution from roofs, streets, and farmlands before flowing into surface and groundwaters. Excessive usage of phosphorus-containing fertilizers and animal waste can lead to eutrophication and other environmental problems in surface water, such as algal bloom, which is detrimental to waterways. Algal blooms can block sunlight, choke waterways, and decomposing algae can release toxins and absorb oxygen from the water causing aquatic plants and animals to suffer. If the build-up continues, it will lead to health risks and the closing of beaches, lakes, or any body of water. Biochar (BC) is a carbonized byproduct of low-cost renewable biomass pyrolysis under low oxygen conditions. It is a considerable absorber of organic and inorganic impurities from aqueous solutions. It is being studied for large-scale applications because it is cost-efficient, can be made on a large scale, and is easy to produce where biomass is available. Douglas fir Biochar was modified with $MgCl_2$ and $FeCl_3$ at a pH of 11 to form magnesium and iron (iii) hydroxide layers on the biochar surface (LDH-BC). It can absorb phosphates in surface water through chemisorption and physisorption mechanisms. Prior to phosphate adsorption experiments, the loading of Mg and Fe and changes in surface area were determined. The removal of dissolved phosphates depends on the solution's pH, temperature, contact time with the BC, the dose of BC, and the solution matrix. To determine the optimum conditions for each parameter, we conducted a series of experiments using LDH-modified BC. Using the results, we will be able to treat stormwater runoff, which in turn will make our waterways safer. Our project aims to design a bioreactor for removing dissolved phosphorus from stormwater.

07
Name: Clavo, Kaylee
Major: Biological Sciences
Faculty Advisor Name, Affiliation: Sidney Creutz, Chemistry
Project Category: Biological Sciences and Engineering

BioInspired Imidazole-Rich Ligands

Calprotectin is an essential protein within the immune system's line of defense against pathogens. By disrupting metal homeostasis, calprotectin is critical to the body's natural immunity defense. This protein is valuable and unique because it is a naturally occurring hexahistidine binding site. Using advanced synthetic and bioinorganic chemistry, these rare sites can be explored and monitored to provide a solution to issues within catalysis and biomedical science. Our work consists of experiments monitoring how efficiently Mn^{2+} and Zn^{2+} will bind to the imidazole-rich ligands with different substituents. The experiments include organic synthesis and titrations of the selected ligands to design a ligand that binds manganese selectively over zinc and more metals. In more depth, titrations are being used to determine the binding affinities of these various ligands. The overall intention of the study is to design bioinspired imidazole-rich ligands and metal complexes that support recent research in manganese biochemistry.

43
Name: Clayman, Harrison
Major: Physics
Home Institution (Other than MSU): The College of Wooster
Faculty Advisor Name, Affiliation: R. Torsten Clay, Physics & Astronomy
Project Category: Physical Sciences and Engineering
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Adiabatic Quantum Monte Carlo Study of Superconductivity in the Frustrated Hubbard Model
This project aims to test the efficiency of Adiabatic Quantum Monte Carlo (AQMC) against previous Quantum Montecarlo methods. In Quantum Monte Carlo, a semi-random seeding method is used to more easily estimate the Hamiltonian of a matrix, which is used to project out the quantum ground state from an initial trial state. For strong interaction strengths or lower temperatures, the estimation becomes noisy and less accurate. In addition, positive and negative electron contributions can nearly cancel out, leading to a further loss of numerical precision known as the Fermion Sign Problem. AQMC takes an alternate approach by gradually increasing the strength of the interaction term, leading to an average lower interaction strength and a lower impact from the Sign Problem. Improving on the original semi-random emulation of electron-electron pairings in lattice structures, the steady increase of the interaction term in AQMC results in more accurate and quicker data even at lower temperatures and higher interaction terms. A problem encountered in all forms of Quantum Montecarlo is the Fermion Sign Problem. As the simulations reach lower temperatures or higher interaction terms, the average sign becomes smaller, requiring exponentially more samples in order to get an accurate result. The increased efficiency of AQMC reduces the impact of the Sign Problem, allowing for accurate results in a greater range of inputs. We tested the method on the Hubbard Model on a frustrated lattice, where enhanced superconducting pair-pair correlations have been seen for electron densities near 1/2 per site. We have confirmed that AQMC produces enhanced pairing correlations, and will be testing the method on the effect of the strength of frustrations on the pairings.

44
Name: Clayton, Ahmya
Major: Biology
Home Institution (Other than MSU): Tougaloo College
Faculty Advisor Name, Affiliation: Xin Cui, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Fernanda Garcia
REU/Research Program: REU

Synthesis & Characterization of Tripodal Ligand for Stereoselective Meta C-H Activation

The production of synthetic ligand-based drug designs plays essential roles in the reactivity and selectivity of reactions catalyzed by transition metals. The goal for this research project is to develop a tripodal ligand that is functional for stereoselective meta-C-H activation. The synthesis of this ligand was executed by a series of experimentations and data analysis. Proton Nuclear Magnetic Resonance (NMR) and Thin Layer Chromatography (TLC) were used to collect and analyze the data. Thin Layer Chromatography separates compounds within mixtures, determines the number of compounds, and the purity of the compounds. Proton Nuclear Magnetic Resonance determines the contents, purity, molecular structure, and identity of the product created. Building a library of ligand designs will advance drug discovery and will aid in the production of pharmaceuticals that are effective, abundant, and less costly.

45
Name: Conner, Rebecca
Major: Chemistry
Home Institution (Other than MSU): Harrisburg University of Science and Technology
Faculty Advisor Name, Affiliation: Nicholas C. Fitzkee, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Chathuri S. Kariyawasam, Joanna X. Xu
REU/Research Program: Mississippi State University REU: Food, Energy, and Water Security

Improving our Understanding of Protein-Nanoparticle Interactions

When nanoparticles come in contact with a biological fluid, they become coated with a layer of proteins called the "corona." This directly affects the fate of therapeutic nanoparticles in the body. However, physical interactions that control protein structure and orientation in the corona are poorly understood. Here, we describe experiments probing the behavior of the GB3 protein on polystyrene (PSNPs) and gold nanoparticles (AuNPs). GB3 is a model protein, and its lysine (K) residues are thought to mediate nanoparticle binding. These lysine residues can be changed to alanine (A) residues to study GB3 in the nanoparticle corona. Prior experiments showed that K19A GB3 forms a monolayer rather than a bilayer on PSNPs and has a higher binding affinity than the other K to A variants. In this project, two methods were used to investigate the GB3 variants. First, fluorescence titration experiments were used to measure the folding stability (ΔG) of variants in the presence of PSNPs. Next, lysine modification by acetylation was used to probe the bound orientation on AuNPs by comparing acetylation patterns in bound/unbound GB3. For PSNPs, we found that the folding ΔG correlated with the ΔG of binding to the nanoparticle. Moreover, for AuNPs, acetylation patterns differ when GB3 is bound to nanoparticles. We are currently using nuclear magnetic resonance (NMR) assignment strategies to determine which lysine residues are affected. The correlation on PSNPs suggests that tighter nanoparticle binding can unfold proteins in the corona. The AuNP data suggest that proteins may have a definite average orientation when bound. Together, these results may lead to better predictions for proteins in the corona.

46
Name: Davis, Ryan
Home Institution (Other than MSU): University of Southern Mississippi
Faculty Advisor Name, Affiliation: Jason Street, Sustainable Bioproducts
Project Category: Physical Sciences and Engineering

Adsorption of methylene blue by activated carbon derived from chicken feather biochar

Chicken feathers are a waste product of the poultry industry that can be turned into biochar due to their high carbon content. Biochar is a solid carbon material produced by pyrolysis of biomass. The applications of biochar include water decontamination and soil enhancement. In this research, biochar was prepared from the pyrolysis of chicken feathers then further modified with the goal of upcycling poultry waste into an adsorbing agent. Biochar was initially prepared by pyrolyzing chicken feathers at 450°C. Chicken feather biochar samples were activated using NaOH, K_2CO_3, and KOH as activating agents to increase the biochar's adsorption capacity by increasing surface area and porosity. Biochar samples were impregnated with activating agents at weight ratios of 1:1 and 10:1 biochar:agent for each activating agent. After impregnation, activations were carried out at 750°C for 4 hours. Adsorption capacity of biochar samples prepared from varying activating agents and varying weight ratios was tested using 48-hour batch adsorption studies with methylene blue as the adsorbate. This adsorbate was chosen because it is a common dye for adsorption studies, allowing for direct comparison of novel adsorbents with previously researched adsorbents. Adsorption capacities were calculated. Biochar with no activation was compared with biochar activated with NaOH, biochar activated with K_2CO_3, biochar activated with KOH, and biochar activated with a novel sonication/aeration method. The results suggest that activated biochar produced from chicken feathers may be an effective adsorbent of industrial pollutants.

08
Name: Dickinson, Nicholas
Major: Sustainable Bioproducts
Faculty Advisor Name, Affiliation: C. Elizabeth Stokes, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
REU/Research Program: USDA-REEU

Evaluation of flood damage on cross laminated timber wall configurations

As construction using cross laminated timber panels continues to increase, the demand for research into how these products will interact with common disasters such as floods is ever more important. This project will give more insight into how 5-ply CLT panels interact with flood water in a household or commercial building setting. The objective of this project is to measure how quickly cross laminated timber products absorb and absorb and desorb flood water given the interaction between the absorbed water and the glue lines that are present in between the individual SYP 2X4s that make up the CLT panels. Within this project, the drying process of the CLT panels is also being monitored as well as air quality and the mold formation that commonly occurs in buildings that experience floods. Four panels will be placed in the wetting rig for three days, and another 4 panels will be tested in a wetting rig for ten days. Once the flood test is finished, the CLT panels will be placed in a drying chamber for 10 days (about 1 and a half weeks) where after an air sample will be taken to measure the air quality. At the end of evaluating the first eight CLT panels, the data showed that the outside layer of the CLT panels showed significant absorption of flood water. The water absorption rate in the radial direction was less than the longitudinal direction due to the organization of the vascular system in trees, and the hydrophobic nature of the glue present in between the layers of the CLT panels. More research is needed to further understand the interaction and absorption of the flood water and the multi-layered CLT panels as well as the effects that the drying process of the CLT panels have on air quality within a building after a flood.

09
Name: Doler, Jacob
Major: Civil Engineering
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Project Category: Biological Sciences and Engineering

Breeding Corn for Resistance to Insects and Aflatoxin

Pests and disease have been a continual problem for farmers when it comes to maize production. There have been a couple of pests that have contributed to substantial crop damage and production loss. The Fall Armyworm and Southwestern Corn Borer are two main pests that have caused significant damage to crop production. Aflatoxin is also a great danger to maize production as aflatoxin is toxic to livestock and causes cancer in humans. It is estimated that aflatoxin contamination alone can cause upwards of $50 to $100 million worth of damage to the corn industry. In order to be able to create lines of plants that have a natural resistance to both pests and disease, field trials must be conducted on a multitude of lines of plants. This is done by infesting plants with either FAW or SWCB larvae and then rating leaf damage 7 to 14 days after initial infestation. Field trials for aflatoxin resistance are done by inoculating the ear of corn itself with *Aspergillus Flavus,* which is what produces aflatoxin. It has been found that there are certain lines of maize, either inbred or hybrid, that have been implemented in different geographical areas with a good resistance to both larvae feeding and aflatoxin. The inbred line Mp715 is one that has natural toxin resistance and there are more inbred lines that have great insect resistance. These inbred lines can be used to create strong hybrid plants resistant to insects and toxins. With the United States being a major producer of corn, it is extremely important that research continues finding the most resistant line of corn in order to increase production capacity around the country.

47
Name: Downs, William
Major: Mechanical Engineering
Faculty Advisor Name, Affiliation: Matthew Priddy, Mechanical Engineering
Project Category: Physical Sciences and Engineering
Co-Author(s): Logan J Betts, Matthew Register

Increment size effects on the thermal response of finite element modeling of AM

Simulating AM processes such as wire arc additive manufacturing (WAAM) has become prevalent in literature over the last decade since it provides a low-cost method to identify process parameters and predict part distortion. However, the development of high-fidelity FEA models using a local moving heat source like the Goldak double ellipsoidal model have exposed a potential issue in previous research, with large artificial temperature spikes occurring over the first few elements at the start of a new layer. This work hypothesizes that when the conservation of total energy is kept, the input energy is the same regardless of element activation volume. This study used the commercial FEA code Abaqus 2019 to simulate a single pass WAAM build. A parametric study was conducted with the increment size and inspections into conservation of total energy (CTE) true or false. The increments analyzed ranged from 0.001s to 1.0s and drastically affected the thermal response of the model. Smaller increments saw artificial temperature spike as high as three times the melt temperature at the beginning of the weld, however, these temperature spikes would quickly fall to steady-state temperatures after the first few increments. Larger increments sizes had the opposite effect, under predicting temperature and only rarely would reach steady state temperature by the end of the analysis. Analysis of CTE true or false was conducted with the same increments and determined that with CTE turned off it consistently undershoot the melt pool temperature. This study concludes that the effects of increment size must be considered when modeling WAAM due to the large variations in temperature.

48
Name: Duckworth, Alison
Major: Chemistry
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Project Category: Physical Sciences and Engineering
Co-Author(s): Mitu Sharma

Metal *N-Heterocyclic* Carbene (NHC) Complexes as Novel Catalysts in Diels-Alder Reactions of Coumarin

N-heterocyclic carbene (NHC) metal complexes are capable of catalyzing challenging oxidative addition reactions. These ligands provide strong σ-donations from ligand to the metal center and π-back bonding from the metal center to the empty p-orbitals of the ligand. These electronic effects modulate the catalytic activity of these NHC metal complexes as Lewis Acid catalysts. Here, we have applied copper(II)-NHC complexes toward a range of Diels-Alder reactions. A series of Diels-Alder reactions with coumarin were studied to optimize reaction conditions and to identify product selectivity. Products of these reactions, when formed or identified, were separated by column chromatography and characterized by ^{1}H and ^{13}C NMR.

10
Name: Duncan, Brylee
Major: Biochemistry
Faculty Advisor Name, Affiliation: Jean Magloire Feugang, Animal & Dairy Science
Project Category: Biological Sciences and Engineering
Co-Author(s): Notsile Dlamini, Mariana Santos-Rivera, Tina Nguyen, Sheng Qinyu, Chen Li-Dunn, Carrie Vance-Kouba

Assessment of seminal plasma quality using Near-Infrared Spectroscopy

The swine breeding industry relies mainly on artificial insemination (AI) using fresh or chilled semen. The lack of reliable predictors for semen quality limits overall fertility rates resulting in unneeded numbers of boars in breeding stocks. Various factors influence semen quality, potentially affecting seminal plasma (SP), which acts as a healthy and protective environment for spermatozoa. We hypothesize the SP could constitute a reservoir for possible non-invasive predictors of sperm quality. We tested the suitability of Near-Infrared Spectroscopy (NIRS) as a rapid, non-destructive technique to examine boar seminal plasma. Fresh semen was harvested from commercial boars (Duroc breed; Prestage Farms) during the 2022 Spring semester. Raw semen samples were classified as Passed (>70%) or Failed (<70%) based on the motility and morphology (≥70%) cut-off criteria. Samples were chill-transported and centrifuged to harvest SP. Clarified SP samples (n=75) were stored at -80°C. Samples were analyzed with the ASD FieldSpec®3 portable spectrometer - 1 mm quartz cuvettes to measure absorption resulting from the interaction of NIR light (750-2500 nm) with functional groups of organic matter. Multivariate analysis of NIRS spectra was conducted using Unscrambler®X v.10.5 (CAMO Analytics-Oslo Norway). Principal Component Analysis and Linear Discriminant Analysis (PCA-LDA) were used in the transformed spectra containing the water information (1300–1600 nm). Failed and Passed groups showed differences in NIRS aquaphotomics data collected between 1300-1500nm. Changes in C1, C5, and C12 (nm) water bands indicated differential associations of water structures with chaotropic and kosmotropic solutes. The PCA-LDA revealed high accuracy (92.2%), sensitivity (94.2%), and specificity (90.3%), while LDA discriminated sub-groups of SP classified as “Extreme Passed,” “Extreme Failed,” and “Common Passed&Failed” samples. The combination of NIRS with aquaphotomics confirms chemical differences between Failed and Passed samples. Studies are ongoing to evaluate and identify potential biomarkers of semen quality. Research supported by the USDA-ARS project #6066-31000-015-00D

11
Name: Ekanem, Edmund
Major: Agricultural Science
Advisor Name, Affiliation: Gary Feng, Agricultural Research Service, U.S. Department of Agriculture
Project Category: Biological Sciences and Engineering

Constructing a Wet Sieve Apparatus to Measure Soil Aggregate Size

Aggregate size distribution and maintaining soil structural stability are important factors in enhancing soil health and land sustainability. The size and stability of soil aggregates can control soil erosion and directly influence water conservation, crop growth, and soil biological process. As macroaggregate sizes increase, soil productivity and health are protected. As soil aggregate stability increases, the susceptibility to soil erosion decreases. Developing technology to effectively and efficiently measure soil aggregate size, distribution and stability can assist researchers, extension agents, and producers to analyze the influence of soil aggregates on soil physical, chemical, and biological processes. The wet sieve apparatus was utilized to measure soil aggregate distribution through sieves submerged in water tanks arranged in the order of descending microns. The apparatus provides sufficient information to accurately measure and calculate aggregates size distribution, mean weight diameter and stability. However, such wet sieve apparatus is not commercially available in market. Therefore, we designed and constructed a wet sieve apparatus in the workshop of Biological Engineering Department at Mississippi State University. The steel bars and rods were precisely cut using a horizontal bandsaw. Construction of the frame was started after completing the cuttings to support the sieve and motor stage. Following the completion of the frame, the sieve nest was welded to secure and shake the sieves in the water-filled buckets. Finally, we connected the 115/208-230-volt motor to the sieve nest to provide a source of power to shake the sieves during testing. Constructing the wet sieve apparatus has allowed soil aggregate distribution measurements to occur efficiently and accurately. The wet sieve apparatus that we built allows soil aggregates size to be measured with high accuracy. As soil aggregate size and distribution are important parameters in soil physical, chemical, and biological processes, the sieve we designed allows factors associated with soil health and crop production to be accurately assessed.

49
Name: Elder, Zoe
Major: Biochemistry
Home Institution (Other than MSU): Millsaps College
Faculty Advisor Name, Affiliation: Todd E. Mlsna, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Prashan Rodrigo, Olalekan Olabode, Dr. Deb Moore, Dr. Mark Lawrence
REU/Research Program: REU-INFEWS: Food, Energy, and Water Security

Adsorption Characteristics of Simulated Ocean Microplastics

Microplastic pollution is a rising concern to marine wildlife as plastic production increases worldwide. Microplastics, smaller than 5 mm in size, are formed from the breakdown of larger plastic pieces. They are found in marine environments and organisms and can increase in concentration up the food chain impacting predator fish, turtles, and dolphins. This study focused on microplastic adsorption and concentration of toxic organic contaminant. Experiments were designed to test the adsorption capacity of Methylene Blue and Rhodamine B dyes on dolphin stomach tissue and three different microplastics: Polypropylene (PP), Polyvinyl Chloride (PVC), and Polyamide (PA). Methylene Blue and Rhodamine B dyes were used to represent organic contaminants that microplastics adsorb in nature. The experiments were performed using purified water and repeated with simulated seawater to analyze adsorption changes with increased salinity. Adsorption capacities of Methylene Blue on PA, PP, and PVC at a pH of approximately 8.1 were 1.944 ± 0.332, 1.835 ± 0.291, and 1.744 ± 0.582 mg/g, respectively, following shaking in a 100 mg/L solution. Polyamide consistently had a slightly higher adsorption capacity than the other two microplastics. To simulate a gastrointestinal environment, qualitative analysis was performed to test if the enzyme pepsin would affect the breakdown of microplastics and dyes. FT-IR, XPS, BET, UV-Vis Spectroscopy, and pyro GC-MS will be used for characterization of the degradation products of microplastics, as well as organic contaminants that may be adsorbed, under the conditions inside the stomach.

50
Name: Emenike, Chiemela
Major: Computer Science
Home Institution (Other than MSU): Belhaven University
Faculty Advisor Name, Affiliation: Steven Gwaltney, Chemistry
Project Category: Physical Sciences and Engineering
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Organic Molecules for Near Infrared Spectroscopy

There exists a desire to find molecules that can absorb and emit light in the near infrared (NIR) region of the spectrum. Such molecules have the potential to be used for bioimaging, since NIR light can penetrate skin much deeper than visible light. The goal of this project was to determine how changes in a series of highly conjugated xanthene derivative molecules affect their absorption and fluorescence wavelengths. Time-dependent density functional theory (TDDFT) was used to calculate the vertical absorption and vertical fluorescence energies. By comparing a series of related molecules, we were able to determine how modifications to the structures shifted the absorbance and fluorescence wavelengths of the molecules. These data can be used to help design new molecules with even longer excitation wavelengths

90
Name: Espy, Allyson
Major: Foreign Language
Faculty Advisor Name, Affiliation: Fumiko Joō, Asian Studies, Classical & Modern Languages and Literatures
Project Category: Humanities and Arts (Oral Presentation)

Exploring Girlhood through Late Meiji and Taisho Period Literature

This paper examines the similarities and differences between male and female authors' presentation of girlhood in fiction from the late Meiji and Taisho period of Japan. This paper argues that even though there are similarities based on the time period, male and female authors illustrate the concept of girlhood differently through their own gendered experiences and how those experiences influence the themes of some of their works pertaining young girls. The similarities of the authors lie within their shared time periods. The late Meiji period authors Izumi Kyōka and Higuchi Ichiyō, and the Taishō period authors Tanizaki Jun'ichirō and Yoshiya Nobuko approach the documentation of girlhood similarly to their respective contemporary due to writing during the time of the same external influences such as literary, societal, and political trends. These trends lead their works to contain a shared topic of the expectations that a young girl must withstand to function in Japanese society. This paper will also discuss the differences that stem from how each author perceives girlhood. Izumi's and Tanizaki's, male outsiders, addressal of girlhood within their respective works is influenced more by the aforementioned external factors and, in return, circumvent the true gravity of girlhood. Higuchi and Yoshiya, having participated in their own form of girlhood, draw more from personal experience, and utilize that knowledge to present girlhood as a journey woven into their overarching story. These differences reflect on the thematic elements of each authors' work that characterize youth, innocence, and the journey from girlhood to womanhood.

12
Name: Faulkner, Halleigh
Major: Electrical Engineering
Faculty Advisor Name, Affiliation: Lauren B. Priddy, Agricultural and Biological Engineering
Project Category: Biological Sciences and Engineering
Co-Author(s): Dani Janus, Caitlin Luke, Alexis Graham, Dr. Matthew Priddy
REU/Research Program: NIH R25 EMCC-MSU Bridges to Baccalaureate Degree Program

Customizable Benchtop Drop Weight Device Simulates Impact Waveform of TLIF Procedure

Transforaminal lumbar interbody fusion (TLIF) is a surgical technique in which an interbody fusion device (IFD) is inserted into a disc space in the lower spine. This procedure is often used for treatment of spinal instability, disc herniation, and spondylolisthesis. The purpose of the TLIF procedure is to stabilize, decompress, and prevent further injury or deterioration of the adjacent lumbar vertebrae. The objective of this research was to use a benchtop device to mimic the peak force, area under the impulse curve, initial slope, and impact duration of the impact waveforms generated during the TLIF procedure in a cadaveric model. The custom-build device utilizes a drop weight and compression platens to produce tunable and repeatable impact force and displacement measurements. In previous experiments, the peak force and initial slope of the waveforms were similar to those from cadaver testing. However, the area under the impulse curve and impact duration did not match those from cadaver testing. It was hypothesized that these remaining waveform characteristics could be mimicked by altering the material of the drop weight. Therefore, drop weight materials with a lower coefficient of restitution were selected to increase impact duration. While stainless steel was used in original testing, the coefficient of restitution was believed to be too high to mimic cadaveric data. Therefore, drop weights with a lower coefficient of restitution (aluminum and zinc) were selected; stainless steel served as a control. Drop weights made of each material, weighing approximately one pound, were dropped. Through repeated testing and analysis, it was concluded that the aluminum drop weight best replicated cadaver data and demonstrated more consistency of the impact waveforms. Zinc also replicated cadaver testing results, but the drop weight deformed from repeated use. Future research includes changing compression forces to better mimic actual spinal compression in the prone position.

13
Name: Flynn, Darrock
Major: Mechanical Engineering
Faculty Advisor Name, Affiliation: Matthew Priddy, Mechanical Engineering
Project Category: Biological Sciences and Engineering
Co-Author(s): Alexis Graham, Charlotte Thompson, Honor Elchos, Dr. Lauren Priddy
REU/Research Program: NIH R25 EMCC-MSU Bridges to Baccalaureate Degree Program

Validation of a perfusion bioreactor with mechanical stimulus for promotion of bone growth

Bone growth after a traumatic event is highly variable and mechanical stimuli, such as loading in compression or shear, can play a significant role in the rate of bone growth. Bioreactors have traditionally been used for testing of biomedical materials because of their ability to mimic physiological conditions of nutrient delivery. However, most bioreactors do not apply dynamic mechanical load, limiting their applicability to the study of bone regeneration. The overall goal of this work is to develop a low-cost mechanical loading bioreactor that can be placed within a benchtop incubator. The bioreactor allows testing of cyclic compression loads on samples, leading to 1500-3000 micro strain. The bioreactor runs semi-autonomously for a user desired number of cycles. One initial objective for validation of the bioreactor was to use various materials such as polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), synthetic bone foam, and magnesium to test the mechanical loading repeatability. A LabView program was developed to gather and display data on force, displacement, and device management. Python scripts were implemented to evaluate data frames for average applied forces and plotting data. Understanding bone growth induced by mechanical stimuli can benefit orthopedic medicine with potential treatments for osteoporosis, broken bone repair, physical therapy, and implant design.

14
Name: Fullerton, Sarah
Major: Forestry
Faculty Advisor Name, Affiliation: C. Elizabeth Stokes, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
Co-Author(s): Daylan Barnes, Dr. Gabrielly d.s. Bobadilla, Elizabeth d.s. Stokes
REU/Research Program: USDA-REEU

Bio-Based Wood Protectants Vs The Weathering Machine

Wood protectants are utilized to improve wood longevity and therefore decrease negative environmental impact of the wood industry. The objective of this experiment is to examine the durability of various bio-based wood protectants with respect to the amount of swelling, shrinking, and damage wood blocks accumulate through the weathering test. The accelerated weathering machine performed cycles of heat. UV-light, and water spray over a period of 14 days. Weight of samples, along with dimensional measurements were taken at 0, 7, and 14 days. According to the length, width, depth, and weight data collected throughout the experiment, tested blends were comparable to positive controls and out-performed untreated controls. These results indicate less water uptake and greater dimensional stability. Due to the natural variability of wood products, maintaining dimensional stability with environmentally safe additives is essential for wood and environmental longevity. Prevention of water uptake is critical in protection of wood products. Further research will include exposure to natural elements over a prolonged period of time.

51
Name: Gautier, Charlie
Major: Aerospace Engineering
Faculty Advisor Name, Affiliation: Kyle Ryker, Raspet Flight Research Laboratory
Project Category: Physical Sciences and Engineering
Co-Author(s): Brandon Means, Dylan Amerson, Dr. Bouteina Driouche

Statistical Sensitivity Analysis of Pilot Scanning Rate Estimation Methods for Detect-and-Avoid and Unmanned Aircraft Systems Standardization

As Unmanned Aircraft Systems (UAS) begin to enter non-segregated airspace alongside manned aircraft, regulations for safe integration will need to be developed by Civil Aviation Authorities (CAAs). CAAs look to academia to provide key research that will influence the performance standards the CAAs may lean on to ease regulatory framework development. One such standard is being developed by the American Society for Testing and Materials (ASTM) International. This standard is for the performance of Detect-and-Avoid (DAA) systems that can be integrated with UAS and which seek to meet the requirement of manned aviation's responsibility to See-and-Avoid (SAA) other aircraft while operating in the National Airspace System (NAS). The cornerstone requirement within that standard for a DAA system is the Risk Ratio. This value is calculated by determining the number of times that a DAA system would mitigate the chance for collisions with other aircraft and dividing that number by how many times it was tested. This research seeks to influence the work being done to determine what an acceptable Risk Ratio value is for DAA manufacturers to test to. The research being done at Mississippi State University's (MSU) Raspet Flight Research Laboratory (RFRL) is taking manned aviation participants and recording their behavior with video. This research then determines the scanning rate of each individual participant by taking random samples of 15, 30, 45, and 60 second video clips as the dataset. Then, a sensitivity analysis is conducted to determine which clip size is most representative of the entire video. A recommendation for clip size, based on this bootstrapping method, is the output of the research and will influence how MSU's RFRL researchers will continue with estimating pilot scanning rate performance.

52
Name: Grover, Seth (Logan)
Major: Mechanical Engineering
Home Institution (Other than MSU): Brigham Young University-Idaho
Faculty Advisor Name, Affiliation: Heejin Cho, Mechanical Engineering
Project Category: Physical Sciences and Engineering
Co-Author(s): Gentry Berry

Instrument Intercomparison of Aerosol Size Distribution

In air filtration research, measuring particle sizing characteristics in the air stream is required to analyze and predict filtration system performance. Commonly used instruments to collect this data are the Aerodynamic Particle Sizer (APS), Laser Aerosol Spectrometer (LAS), and Scanning Mobility Particle Sizer (SMPS), where each uses different techniques to analyze the particles. Because of these different techniques, the instruments produce similar but distinctly different size distributions. To determine that the collected data from different instruments is valid, a baseline can be established to investigate the instruments further. An inertial impactor is used to create this baseline and determine the accuracy of the data from the APS, LAS, and SMPS. An impactor uses the physical properties of the particles (e.g., weights in different size range) to determine the particle size distribution. By comparing the impactor size distribution to the instruments independently, the accuracy of each instrument can be determined. To perform the necessary tests, an existing test stand is used to meet the specific needs of the experiments. The test stand, known as the Small Scale Test Stand (SSTS), is designed to run experiments with a variety of generated particles to determine performance of various filter media. Using the SSTS, the individual instrument's particle size distributions are evaluated and compared to the impactor's distribution. From the comparisons, conclusions are determined, and further discussion is given on their use in future experiments.

15
Name: Gupta, Surabhi
Major: Wildlife, Fisheries & Aquaculture
Faculty Advisor Name, Affiliation: Raju Bheemanahalli, Plant and Soil Sciences
Project Category: Biological Sciences and Engineering
Co-Author(s): William Kingery, K.R. Reddy
REU/Research Program: College of Agriculture and Life Sciences URSP

Effect of chilling stress on seed germination ability in cotton

Current cotton planting dates in Mississippi are often exposed to unfavorable environments during the peak flowering and boll formation. These production challenges can partially be alleviated by adopting early-season planting. However, seedling emergence and seedling vigor are hampered by early-season planted cotton due to chilling weather. Under sub-optimal temperatures, germinating cotton seeds suffer from injury. This study evaluates the impact of chilling stress on the germination ability of twenty-five cotton cultivars accessible to producers and suitable for production in the U.S. southern region. Using seeds available in their commercial form, germination ability parameters were measured under optimum (28 °C) and chilling (18 °C) temperature conditions. The germination count was taken twice every day for one week. At seven days of treatment, the radicle length and dry weight were taken to calculate the seed vigor index. All germination and vigor parameters were reduced under chilling stress. Time to 25 % and 50 % germination was more under chilling stress. On average, the time to 50 % germination increased by 51.5 hours, and radicle weight decreased by 71 % under chilling stress compared to control. At seven days of chilling treatment, there was a significant difference among cotton genotypes in vigor index. On average, the vigor index decreased by 83 % under chilling stress compared to the control treatment. PHY400 and ST5091 showed the highest vigor index, while NG3299 had the lowest vigor index due to lower germination percentage and radicle growth at the chilling treatment. A cotton cultivar with higher fitness traits might provide opportunities for farmers to shift planting dates towards cooler temperatures. Based on the findings of this experiment, the genotypes PHY400 and STNV4990 performed better under chilling stress and could be recommended to producers for early-season planting.

53
Name: Hansen, Annaleena
Major: Chemistry
Home Institution (Other than MSU): University of North Georgia
Faculty Advisor Name, Affiliation: Sidney Creutz, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Tom Boggess

Synthesis of cesium bismuth sulfide, a precursor to lead free perovskites

A major topic of research in recent years has been lead halide perovskites, for their impressive power conversion efficiencies when applied to the structure of a solar cell. However, due to the toxicity of lead and the poor overall stability of lead halide perovskites, a specific interest in synthesizing lead free, more stable perovskites has become a topic of interest. One option in achieving a lead-free perovskite is a mixed anion approach, with the chemical formula $CsBiChX_2$, where Ch is a chalcogenide and X is a halide. Unfortunately, a direct synthesis route is not feasible, and a cesium bismuth sulfide ($CsBiS_2$) precursor is required. Two major synthesis pathways were investigated to form $CsBiS_2$. In the first pathway, the reagents cesium hexamethyldisiloxane, bismuth hexamethyldisiloxane, diethylthiourea, and oleylamine were combined and reacted. The other pathway utilized cesium dicyclohexyldithiocarbamate, bismuth diethyldithiocarbamate, and oleylamine. To characterize and confirm a successful synthesis, powder x-ray diffraction (pXRD), as well as transmission electron microscopy (TEM) were performed. By comparing the bulk $CsBiS_2$ x-ray pattern, it was determined that by using the dithiocarbamate precursors, there was great potential that the correct material was made. To further study the compatibility of the dithiocarbamate precursors, concentration of reagents, molar stoichiometry, and the solvent were altered and researched. After $CsBiS_2$ is successfully made and characterized, the goal is to achieve a perovskite structure through a halide anion exchange.

54
Name: Hernandez, David
Major: Mathematics
Home Institution (Other than MSU): University of Central Florida
Faculty Advisor Name, Affiliation: Hyeona Lim, Mathematics and Statistics
Project Category: Physical Sciences and Engineering
Co-Author(s): Gerardo Villalobos (University of Texas at Austin), Shiraz Mujahid (Mississippi State University)
REU/Research Program: REU in computational methods with applications in materials science

Study and Development of State-of-the-Art Nonlocal Means based Image Denoising Methods

At the forefront of effective denoising techniques, Nonlocal Means (NLM) precisely denoises a pixel in a noise-corrupted image by estimating its true value as a weighted average of the pixels over the entire image. To save on computational complexity, often a sample window is used rather than the entire image. The adaptive window NLM by Kervrann and Boulanger uses statistical analysis to determine the proper window size for each pixel. This is done by taking the largest window for which the estimated value only varies from the other estimators by a statistically probable amount. This weighted sum procedure is also optimized by only computing the weights over a specific region rather than using the entire square sample window. This is accomplished by setting the weight between two pixels to 0 if we can prove that the neighborhoods of each pixel differ significantly. My research aims to analyze conventional NLM based methods, develop new selection criteria for which pixels in the window to consider for the weighted average, as well as combine the selection criteria with the adaptive window technique to develop new approaches that make up for shortcomings in accuracy and computation time. Numerical results indicate new methods produce faster and more accurate denoising compared to conventional NLM based methods.

55
Name: Heson, David
Major: Physics
Faculty Advisor Name, Affiliation: Bill Robertson, Middle Tennessee University
Project Category: Physical Sciences and Engineering
Co-Author(s): Jack Liu
REU/Research Program: Middle Tennessee University Computational Science REU

Optimization of Optical Multilayers for Biological Sensing Using Bloch Surface Waves
We developed an interactive computer program in Python that optimizes the design for multilayer arrangements that exhibit Bloch Surface Wave behavior, which can be used to create a cheap and precise biodetector. A Bloch Surface Wave is a guided electromagnetic wave which is bound to the surface of one of the layers. When a Bloch Surface Wave occurs, the reflectivity of the system is lowered significantly, potentially even to zero, causing an easily observable pattern in the light reflected off the optical multilayer system. Using the Bloch Surface Wave phenomena, it is possible to detect very fine changes in material width or optical index, allowing for the detection of events such as antigen-antibody reactions. The computational simulations of the generated multilayer arrangements show sensibilities in terms of degrees per RUI (Refractive Index Unit) at an incident light wavelength of 650 nanometers, and the program can create a multilayer arrangement for any desired incident light wavelength. Future exploration of the multilayers designed this way is warranted, such as the behavior of multilayers with multiple Bloch Surface Waves present.

16
Name: Holtman, Jacob
Major: Medical Technology
Faculty Advisor Name, Affiliation: Ling Li, Biological Sciences
Project Category: Biological Sciences and Engineering
Co-Author(s): Lei Wang

Arabidopsis orphan gene: transcription regulation and function

Carbon and nitrogen are essential for plant growth, development, and responses to environmental stresses. The ability to optimize protein productivity of plant-based foods has an extensive impact on both world health and sustainability. The *Arabidopsis thaliana* orphan gene Qua-Quine-Starch (QQS) has been identified as a regulator of carbon and nitrogen partitioning when expressed in crop plant species. While its molecular mechanism via interaction with the conserved transcription factor NF-YC4 has been studied, the mechanism to regulate the QQS transcript level is still not fully understood. Previous research from our lab suggested that QQS suppresses hypocotyl growth that is regulated by phytochrome interacting factors (PIFs) through trehalose mediated sugar signaling. Here, to answer how QQS affects hypocotyl growth, through the motif analysis at the genes' promoter and by information from the literature, we found a potential gene candidate for QQS-NF-YC4's target: *ABI*. It was reported to be involved in PIF-mediated hypocotyl growth. ChIP-qPCR revealed that NF-YC4 can bind to ABI's promoter and QQS is required for this binding. The qRT-PCR results showed that the *ABI* gene transcript level indeed change corresponding to sugar, in sugar-signaling gene knockout mutants, or in *QQS* knockout or overexpressing mutants. Our research helps to fully understand how *QQS* is regulated under sugar signaling, and how QQS functions to affect hypocotyl growth. Taken together, our study reveals a novel molecular mechanism on regulation of *QQS* transcript level through metabolites and signal factors, and how it is functional through other signal factors.

56
Name: Hopson, Jasmine
Major: Chemistry
Home Institution (Other than MSU): Bridgewater College
Faculty Advisor Name, Affiliation: Steven Gwaltney, Chemistry
Project Category: Physical Sciences and Engineering
REU/Research Program: Computational Methods with Applications in Material Science

Effect of Ionic Liquids on Lipids

It has been shown that ionic liquids can be used as carriers to increase the absorption of drugs and nanoparticles through skin. To better understand how this happens, we have simulated the interaction of a model ionic liquid with a lipid bilayer. Each repeat unit in the simulation consisted of 2746 choline and 2746 geranate molecules with 144 POPC lipids in each of the two layers, arranged in a three-dimensional periodic system. The unit cell contained a total of 170,400 atoms. Molecular dynamics simulations with the Amber force fields were used to calculate how the ionic liquids behave when near the lipid bilayer and to see if the lipid bilayer would be affected by the ionic liquid. Initial results show that the geranate can penetrate into the lipid bilayer. This is a potential first step towards disruption of the bilayer by the ionic liquid.

57
Name: Hyland, Hannah
Major: Geoscience
Faculty Advisor Name, Affiliation: Christopher M. Fuhrmann, Geosciences
Project Category: Physical Sciences and Engineering

Examining the relationships between the daily range in temperature, heat index, and heat-related mortality in the contiguous United States

There is increasing evidence of a statistical association between the daily range in temperature (i.e., the difference in daily maximum and minimum temperatures) and various health outcomes. Most studies conclude that large ranges in daily temperature can lead to more harmful health effects. However, in the case of extreme heat, smaller ranges in daily temperature, particularly those characterized by warmer minimum temperatures, may actually be more harmful to human health. This is an important consideration, as minimum temperatures have been increasing faster than maximum temperatures in many places over the past several decades due to increases in humidity and urbanization. Recent research has examined the meteorological factors associated with daily temperature variability, but at one location and over a relatively short period of time. In addition, the author is unaware of any study examining the daily range in apparent or "feels like" temperature (i.e., heat index), which is strongly linked with human health and used operationally in the United States to warn for extreme heat. In this study, a climatological analysis is conducted on the daily range in warm season (May-October) temperature and heat index across the contiguous United States. Specifically, variability in the daily range of temperature and heat index is assessed over a 40-year period using hourly weather data from 103 metropolitan areas and related to the prevailing synoptic-scale environment using the Spatial Synoptic Classification. To further clarify the association between daily heat exposure and human health, statistical relationships are examined between the daily range in temperature and heat index and estimates of heat-related mortality for each metropolitan area.

82
Name: Issac, Ania
Major: Psychology
Faculty Advisor Name, Affiliation: Kathleen Ragsdale, Gender Impacts Lab, Social Science Research Center; Mary Read-Wahidi, Gender Impacts Lab, Social Science Research Center
Project Category: Social Sciences
Co-Author(s): Netsayi Mudege, Lizzy Muzungaire, Robert Kolbila, Priscilla Funduluka, Toose Muzungaile
REU/Research Program: ORED Undergraduate Research Program

FishFirst! Zambia Phase II: Conducting Nutrition Trainings and ComFA+ Taste-Tests Among Mother-Infant Pairs at Lake Kariba.

Funded by USAID and Feed the Future Fish Innovation Lab, FishFirst! Zambia's name is derived from the project's goal to promote consumption of fish among women of reproductive age (WRA) and infants and young children (IYC) in the "first" 1,000 days of life. This is the time-period from conception to 2 years of age and encompasses the important nutritional transition for IYC from exclusive breastfeeding to eating solid foods. To help achieve this goal, FishFirst! Zambia Phase II culminated in a week-long set of community mobilization and research activities at Lake Kariba in Zambia's Southern Province, which were completed on June 24, 2022. Lake Kariba, a vast human-made waterbody, is the leading source of the tiny sardine-like fish, *Limnothrissa miodon* (locally known as Kapenta) for Zambia. Our participants included 37 mother-infant pairs recruited from the Districts of Gwembe, Siavonga, and Sinazongwe. Our research activities were implemented at Siavonga, where we brought the 37 mother-infant pairs (*N*=72) together over three days. Our Phase II activities included conducting: 1) A 3-hour Nutrition Training focused on Kapenta, 2) Two ComFA+ Cooking Demonstrations over 2 days, 3) Mothers' ComFA+ Taste-Test, and 4) Infants' ComFA+ Taste-Test. For their taste-test, mothers evaluated the sensory attributes and overall acceptability of four ComFA+-fortified dishes, *Nshima* (maize porridge–the national dish of Zambia), Kapenta Chutney, *Chibwabwa Fisashi* (a savory dish of dried pumpkin leaves), and Bean-Vegetable Soup. Kapenta Chutney and Chibwabwa Fisashi scored highest for "overall acceptability," such that 100% (*n*=37) of mothers 'liked/very much liked" both these ComFA+-fortified dishes, followed by ComFA+-fortified Nshima at 91.9% (*n*=34), while the ComFA+-fortified Bean-Vegetable Soup placed a distant fourth at 48.6% (*n*=18). This set of preliminary results suggest that ComFA+-fortified dishes may be viable ways to promote consumption of fish targeting WRA and IYC.

58
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Major: Mathematics
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Project Category: Physical Sciences and Engineering
Co-Author(s): Madelynn Schina
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Cluster detection in nanofibrous materials using scan statistics

Scan statistics is a very valuable tool that has many applications in various disciplines. One of the applications it is commonly found to be useful for is scanning images, specifically images of nanofibers. The production of nanofibers has yet to be optimized to its fullest potential, resulting in multiple defects like clusters and beads that can compromise the integrity and stability of the material. The goal of this project is to create an algorithm that will scan through provided images of the nanofibrous material to determine the location of any defects present. To start, the program processes the images by reading the images into matrices and converting them into a black and white scale. After the image has been scanned and processed the algorithm obtains a scan statistic by taking the summation of a set window size and saving the values into a matrix. A critical value function is then run-on images within the normal group to find what is the critical value to then compare against the anomalous images. If the critical value is higher than what was found on the normal images, then there is a cluster present. Future work looks to improve these algorithms by altering parameters and testing more images.

59
Name: Jackson, Amber
Major: Psychology
Home Institution (Other than MSU): Tougaloo College
Faculty Advisor Name, Affiliation: Richard Baird, Biochemistry, Molecular Biology, Entomology and Plant Pathology
Project Category: Physical Sciences and Engineering
Co-Author(s): Hannah Purcha

In vitro* and *in vivo* studies of *Macrophomina phaseolina

Macrophomina phaseolina (Mp) is a generalist soil-borne fungus; with over 500 hosts that infects important agricultural and horticultural crops all over the world including soybean, potato, cotton, strawberries, and more. Mp thrives in hot and arid conditions as a high temperature low moisture growing fungus. As climate change presents increasingly favorable conditions for Mp to thrive, research into this pathogen is vital.This research aims to evaluate the impact of environmental conditions on the growth and pathogenicity potential of Mp on soybean. Two *in vitro* growth studies of Mp compared variable temperatures, and a complementary *in vivo* greenhouse study evaluated pathogenicity potential of select Mp isolate infected soybeans under normal and drought conditions with temperatures ranging from 70°F - 99°F. The *in vitro* experiment assessed various Mp isolates' responses to different temperatures ranging from 21°C - 45° C and correlated this data to their original location and morphology. For the greenhouse study, soybean plants were inoculated with Mp isolates to assess variations in pathogenicity under normal and drought stressed plants. Additionally, to evaluate the impact of phosphorous levels on Mp growth, two growth studies were conducted. Radial growth of three Mp isolates was measured on solid basal media plates with varying amounts of potassium phosphate. To quantify overall biomass, the three isolates were also grown in liquid basal media that contained varying amounts of potassium phosphate and their dry weights were measured. The goals of these physiological growth response studies of Mp were to 1) determine how various isolates of Mp respond to different temperatures and phosphorus levels in controlled laboratory conditions and 2) to assess Mp isolate efficacy on soybeans plants grown in drought versus normal moisture levels.

83
Name: Jackson, Rhiannon
Major: Psychology
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Project Category: Social Sciences

Handicap Parking Availability on MSU Starkville Campus

The purpose of this investigation was to determine if the overall number of handicapped spots on the MSU Starkville campus are adequate to the student population. According to Mississippi parking requirements, parking facilities with 1001 spots and over are required to have a minimum of 20, plus one for each 100, or fraction there-of, over 1000; however, that minimum number may not be sufficient for the needs of the student body. This study involved both collecting background information from Parking Services and conducting an in-person survey of perceived adequacy. There are a total of 13,900 permit spots located on the Starkville campus. Therefore, the campus is required to have 149 ADA spots. There are 4200 Commuter spots, 3300 Resident spots, 1300 Greek spots, 2600 Staff spots, and 2500 “Any Valid Permit” spots. There are 487 ADA spots available (3.5%). All permits, not including Staff, only have access to the ADA spots in their zone. 88 out of 4200 (2.1%) Commuter spots are ADA spots. 17% of these spots are open and can be accessed by any one on campus in need of an ADA spot. 13% of these are located at the Vet school, away from central campus. Four out of fifteen of the commuter lots on campus had zero ADA spots available. 11 adults completed the brief survey of handicap parking availability. On average, participants tended to rate handicap parking on campus to be of “moderate” accessibility. Though MSU is compliant with state regulations, the amount available does not seem to be sufficient for the needs of students on campus. Future re-allocations of permitted spots across lots should consider making more ADA spots available to all permits and lots to increase access for the student body.

17
Name: Jefferson, Tydranique
Major: Biochemistry
Home Institution (Other than MSU): East Mississippi Community College
Faculty Advisor Name, Affiliation: Seung-Joon Ahn, Biochemistry, Molecular Biology, Entomology and Plant Pathology
Project Category: Biological Sciences and Engineering
Co-Author(s): Sena Isbilir, Courtney Wynn

Molecular cloning of two glucose-conjugating enzyme genes, UGT33b and UGT40g, from the corn earworm

Corn earworm (*Helicoverpa zea*) is known as a serious pest in the agricultural world. Some of the crops they eat include corn, cotton, tomato, beans, alfalfa, tobacco, and hot pepper. They prefer to feed on the more nutritious tips of corn ears, cotton bolls, tomato fruits, and bean pods. Uridinediphosphate glycosyltransferase (UGT) is an enzyme that helps regulate metabolic homeostasis by sugar conjugations, playing an important role in adaption to xenobiotics. Among many others, two UGT genes, UGT33b and UGT40g, were selected, because they were highly induced upon feeding on the fruits of hot pepper (*Capsicum* sp.), probably associated with detoxification of plant defensive compounds, such as capsaicin from the *Capsicum* fruits. In this research, we aimed to identify these two UGT genes from the larvae. For this purpose, we extracted total RNAs from each of the larval midgut and fat body, where the most metabolic activities occur in the caterpillar. The RNAs were converted into complementary DNA (cDNA) to amplify the target sequences from. Using gene-specific primers and a proof-reading DNA polymerase (Phusion DNA polymerase), two UGT genes were amplified by polymerase chain reaction (PCR). The PCR products were separated by 1.2% agarose gel electrophoresis and the band with an expected size was extracted. After ligating the sequences in a plasmid, called pJET vector, we transformed the recombinant plasmid into *Escherichia coli* to produce the obtained sequences within the bacterial colonies. Discovering UGT50 and UGT48 in the *H. zea* adult moth would pave a road for further research on their molecular structures, biochemical characterizations, and physiological functions.

18
Name: Jian, Xinyan
Major: Biomedical Engineering
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Project Category: Biological Sciences and Engineering
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REU/Research Program: ORED Undergraduate Research Program

Rapid and non-destructive evaluation of seed quality in row crops

Seed quality of corn and soybean are directly related to plant-human health and international trade. Genetic enhancement in seed quality was largely neglected due to the lack of high throughput screening tools. Traditionally, laboratory-based destructive seed quality (protein, oil, starch, and other) measurement methods are laborious, expensive, and time-consuming. The newly developed Near-Infrared Reflectance Spectroscopy (NIRS) allows the non-destructive phenotyping of many samples. The calibrations developed by the DA 7250 manufacturer were used with the default setting to assess seed quality. Ten soybean genotypes and twenty-seven corn genotypes were phenotyped for seed quality. A significant variation was observed in starch ($p < 0.001$), protein content ($p < 0.001$), and oil ($p < 0.001$) across genotypes and crops. 13 corn genotypes had starch content over 60 % with B97 and Mo17 having the highest content of 63 %. The protein contents for B97 and Mo17 were 10 % and 12 %. Genotype Oh7B had high oil (4.5 %) and protein (15 %) content with low starch content (54.5 %). In corn, starch was negatively correlated with both protein and oil. Oil and protein contents of soybean varied with $p < 0.001$, while starch content varied significantly across genotypes ($p < 0.01$). Soybean genotypes from private seed companies, certified growers, and breeding lines had a narrow range of oil (21-22%). R15-2422 genotype had the highest protein content with 41 %. All the genotypes had extremely low starch content compared to corn. In conclusion, using NIRS, scientists could determine the quality composition of seeds to enhance breeding efficiency. Meanwhile, developing high-yielding varieties with better quality is optimal.

60
Name: Johnson, William
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Project Category: Physical Sciences and Engineering
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Controlled Thermal Degradation in High Carbon Yielding Resins Derived from Bis-ortho-diynylarene (BODA) and Poly(arylacetylenes)

Bis-ortho-diynylarene (BODA)-derived resins have been recognized within the hypersonic materials community as a promising standard for next-generation high carbon-yielding matrix precursors. As a base unformulated resin, they can be synthesized via a three-step process from commercially available bisphenols and thermally polymerize to give polynaphthalene networks which convert to carbon in unprecedented yields (>80%). Reactive additives from small aromatics with reactive unsaturation (e.g. alkene and alkyne) are ideal viscosity modifiers for expanding the melt processability of BODA-derived resins without detriment to the high carbon yields or quality of carbon produced. Controllably changing the melt viscosity is desired to expand the scope of processability from vacuum bag assisted infiltrations of simple carbon composite panels to making complex geometries and filament-wound composite structures. We demonstrate controlled thermal degradation in BODA-derived resins formulated with low molecular weight reactive additives like poly(phenylacetylene), poly(diethynylbenzene), and poly(methyl-6,7-diphenyl-2-naphthalenecarboxylate). Furthermore, increased thermal-oxidative stability for each of these additives is accomplished by B-staging followed by copolymerization with a BODA monomer to make highly branched processable copolymer additives. The reaction chemistry between each of these additives with the aggressive naphthalene diradicals produced from the Bergman cyclization of BODA are characterized via FT-IR, GPC, 1H-NMR, and UV-Vis.

61
Name: Koloc, Jackson
Major: Physics
Faculty Advisor Name, Affiliation: Dipangkar Dutta, Physics & Astronomy
Project Category: Physical Sciences and Engineering

Implementation of Bayesian Analysis to Refine the Definition of the Proton Charge Radius

The proton has been a subject of study for over a century now, and yet, so much is still not known about it. One of the more prevalent characteristics of the proton is its RMS charge radius. The PRad experiment was conducted in order to try and measure this charge radius by utilizing a windowless hydrogen gas target with a low beam background, a very low momentum-transfer range, and an environment that allows electron-proton and electron-electron scattering to be deleted simultaneously. This method allowed for a precise control of the systematic uncertainties to try and extract the most accurate measurement of the proton radius possible. Using previous data from the PRad experiment and a program that utilizes a method called Bayesian Analysis, we are trying to extract the proton radius with a smaller error range. Bayesian Analysis aims to continually learn from previous information gathered from this experiment allowing it to build upon itself and ultimately achieve a much more precise measurement.

19
Name: Lee, Seth
Major: Biochemistry
Faculty Advisor Name, Affiliation: Seung-Joon Ahn, Biochemistry, Molecular Biology, Entomology and Plant Pathology
Project Category: Biological Sciences and Engineering
Co-Author(s): Sena Isbilir, Courtney Wynn

Molecular cloning of two glucose-conjugating enzyme genes, UGT50 and UGT48, from the corn earworm adults

Helicoverpa zea, also known as corn earworm, is a major pest that causes severe damage to crops including corn, cotton, and tomato during its larval stage often by consuming a majority of leaf tissues and bolls of the plants. In order to counter this pest, it is important for scientists to get a clear understanding of its physiology. Uridinediphosphate glycosyltransferase, or UGT, is an enzyme for assisting the production of specific biochemical reactions via glycosylation, which enables to detoxify or metabolite unwanted substrates. By obtaining a deeper understanding of the UGT mechanism inside the pest, it is possible to produce effective pest management strategies against them or reinforce the plant defense mechanism to produce allelochemicals that this pest is unable to synthesize naturally. The main goal is to identify two UGT genes, UGT50 and UGT48, from *H. zea*. UGTs are usually predicted to be expressed in the larval intestines, but these two UGTs were not found in the larval stage according to our preliminary experiments. In this study, we aimed to detect these two genes from adult moths. For this purpose, we extracted total RNAs from adults, separately from male and female. The RNAs were converted into complementary DNA (cDNA) to amplify the target sequences from. Using gene-specific primers and a proof-reading DNA polymerase (Phusion DNA polymerase), two UGT genes were amplified by polymerase chain reaction (PCR). The PCR products were separated by 1.2% agarose gel electrophoresis and the band with an expected size was extracted. After ligating the sequences in a plasmid, called pJET vector, we transformed the recombinant plasmid into *Escherichia coli* to produce the obtained sequences within the bacterial colonies. Discovering UGT50 and UGT48 in the *H. zea* adult moth would pave a road for further research on their molecular structures, biochemical characterizations, and physiological functions.

62
Name: Linden, Courtney
Major: Biochemistry
Home Institution (Other than MSU): High Point University
Faculty Advisor Name, Affiliation: Colleen Scott, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Hari Giri
REU/Research Program: REU

Phenothiazine-Based Polymer as Polyaniline Derivative for Optoelectronics Applications

Polyaniline is a widely used conducting polymer, which is easy and inexpensive to prepare. It can be used for different applications, including sensors, corrosion inhibitors, photovoltaic cells, energy storage devices, and electromagnetic shielding materials. It is known for its excellent electrical, redox, and mechanical properties. However, polyaniline has two significant problems - electrochemical aging and insoluble in common organic solvents. To address these deficiencies, we prepared PANI-derivatives based on the phenothiazine core to investigate their redox stability and solubility. The PANI-derivatives were synthesized based on the polymerization of phenothiazine with *p*-phenylenediamine and tetramethyl *p*-phenylenediamine as the co-monomers using the Buchwald-Hartwig cross-coupling reaction. The branched alkyl side chains on the phenothiazine moiety and the benzene ring promote solubility of the polymers. The structure of the polymer was determined by ^{1}H NMR and IR spectroscopy. UV/vis spectroscopy is used to investigate the effective doping behavior of polystyrene sulfonic acid, trifluoroacetic acid, and camphor sulfonic acid on the polymer. EPR and UV/vis spectroscopy are used to demonstrate the production of stable radical cations throughout the backbone of the acid doped phenothiazine-based copolymers. , The presence of radical cations is important for the electrical conductivity of the polymers. The conductivity was measured by the four-point probe method. DSC and PXRD was used to study the effect of crystal packing on its conductivity. In this presentation, we will report the results of our findings.

63
Name: Lindsey, Kyle
Major: Aerospace Engineering
Faculty Advisor Name, Affiliation: Matthew W. Priddy, Mechanical Engineering
Project Category: Physical Sciences and Engineering
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Comparison of FDM and L-PBF Additive Manufacturing of 316L Stainless Steel

Conventional metal-based additive manufacturing (AM), such as laser powder bed fusion (L-PBF), has paved the way for cost and time effective rapid prototyping and one-off production. However, these types of additive manufacturing have very large initial costs, with machines often costing as much as 500,000 USD. These large initial costs have contribution to the lack of large-scale adoption of metal AM. However, polymer based Fused Deposition Modeling (FDM) has become very common due to its low cost of entry, some as low 189 USD. With the advent of metal filaments for FDM 3D printers, the cost of metal AM has drastically decreased. This study compares printing UltraFuse 316L Metal 3D filament on both the Creality Ender 3 V2 and the MakerBot Method X to L-PBF. To analyze the part performance, mechanical and density testing were performed on tensile specimens printed with varying print settings and compared with parts produced by L-PBF AM process. During this study, the MakerBot Method X printed consistent, fully dense specimens that have Young's Moduli and ultimate tensile strengths similar to that of 316L L-PBF stainless steel. Meanwhile, the specimens printed on the Creality Ender 3 v2 displayed variation in mechanical properties and specimen density.

20
Name: Lyons, Genesis
Major: Biochemistry
Faculty Advisor Name, Affiliation: Priyadarshini Chakrabarti Basu, Biochemistry, Molecular Biology, Entomology and Plant Pathology
Project Category: Biological Sciences and Engineering
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REU/Research Program: ORED Undergraduate Research Program

Palynology as a tool to understand honey bee forage

All animals search for their source of nutrition. Optimal nutrition is the key in sustaining a healthy life. In the case of the honey bees, *Apis mellifera* L., pollen and nectar from flowers are the two primary natural sources of both macro and micronutrients. Pollen is a crucial component of honey bee nutrition, providing amino acids, lipids, vitamins, salts, phytosterols and essential minerals. It is important to ensure that all bees have access to a diverse and staggered bloom throughout the year. This in turn also makes it crucial that we understand their foraging patterns by finding the specific floral species that they are attracted to and regularly forage from. In this study, simple palynology methods, such as fuchsin staining and acetolysis, act as beneficial tools in understanding the foraging habits of the honey bees by identifying the plant species. Pollen was collected and stained by the following methods: (1) pollen collected using front porch pollen traps in our campus research apiary, color segregated and acetolyzed; (2) pollen grains on flowers were either directly touched with fuchsin jelly strips or flowers were tapped to dislodge pollen directly on to the fuchsin jelly strips and identified. In both methods, we used microscopy to image, scale and identify the plant species. Application of these methods will lead to understanding the connections between flowering species and bee species and the bees' preferences for foraging.

64
Name: Martinez Diaz, Wilson
Major: Aerospace Engineering
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Project Category: Physical Sciences and Engineering

Modular Framework for Lattice Structure Mechanical Simulations

Recent innovations in additive manufacturing (AM) equipment have allowed engineers and scientists to develop complex geometries that were not possible with subtractive manufacturing, such as lattice structures (LS). The high strength to weight ratio of lattice structures, and the customizability makes them suitable to use in different industries like automotive, medical, and architectural. Currently the methodology to perform finite element analysis (FEA) on lattice structures is labor intensive, and strenuous for lattices that have varying struts sizes and custom parameters. The focus of this research is the creation of a modular framework that can take any lattice structure and perform mechanical FE simulations. Using meshing software, a finite element analysis solver, and a Python script has allowed to create a framework that can simulate compression and/or tension of a lattice structure with varying density, struts, and materials. This framework can be used by any industry to test substituting solid structures for porous lattice structures with higher strength ratios.

21
Name: Matthews, Erin
Major: Biochemistry
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Project Category: Biological Sciences and Engineering
Co-Author(s): Alexander J. Cutright

Thermodynamically Characterized Conformational Changes of Zinc Dependent SczA

Zinc(II) ions play critical roles in all known life. It can act as a functional ion in metalloenzymes, a structural cation in proteins, and an effective signaling agent. To maintain homeostasis, the intracellular concentration of zinc(II) is strictly controlled by a family of metal-regulatory proteins in both prokaryotic and eukaryotic organisms. In *S. pneumoniae,* two transcription factors associated with the TetR family share the responsibility for Zn^{2+} homeostasis. One of these proteins is SczA. SczA has been shown to bind DNA in two different locations, and Zn^{2+} controls the specificity of this process. Here we report our efforts to use the thermodynamic methods ITC and DSC to measure the structural stability in SczA (apo), Zn_2SczA (holo), SczA/DNA, and Zn_2SczA/DNA states. The determination of these thermodynamic qualities provides a basis of the dynamics of the SczA system and a deeper understanding of how this transcription factor modulates Zn^{2+} concentrations through a series of thermodynamically regulated conformational changes.

22
Name: McDevitt, Reagan
Major: Biochemistry
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Project Category: Biological Sciences and Engineering
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Alterations in Pressure Induced Wound Healing with Exposure to Organochlorine Pesticide Metabolites in a Diabetic Mouse Model

Approximately 25% of type 2 diabetics develop diabetic foot ulceration in their lifetime, with 15-20% of these cases resulting in incomplete healing and limb amputation. While exposure to organochlorine pesticides has been positively associated with type 2 diabetes, the relationship between exposure to these pesticides and diabetic wound healing has not been examined. Thus, the current study was designed to determine if exposure to an environmentally relevant mixture of three prevalent organochlorine pesticide metabolites, DDE, trans-nonachlor, and oxychlordane (DTO), alters wound healing in a diabetic mouse model. Briefly, male C57BL/6J or diabetic male TALLYHO mice were dosed for 5 consecutive days with either corn oil or DTO then rested for 12 days. Following the rest period, a wounding procedure using magnets consisting of two twelve-hour on, twelve-hour off cycles allowed for the formation of pressure ulcers. To determine the effects of DTO on *Staphylococcus aureus* infected pressure wounds, those mice were inoculated after the final magnet cycle. Wound areas were measured to track wound healing. Uninfected TALLYHO mice given DTO had significantly less wound resolution on days 4, 8, and 12 compared to vehicle, while C57BL/6J mice given DTO only had significantly less wound resolution on day 12 compared to the vehicle. On day 13 post wounding, expression of *Tgf-β*, *Krt5*, and *αSma* were significantly lower in DTO-treated TALLYHO mice compared to vehicle TALLYHO mice which may account for the DTO-induced delay in wound resolution in diabetic animals. In treated/infected TALLYHO mice at day 1, wound areas were significantly increased compared to uninfected. C57BL/6J mice did not have significant alterations in areas on days 1-12 post wounding/inoculation. Therefore, the current data indicate exposure to organochlorine pesticide metabolites significantly delays wound resolution in diabetic animals and thus may make diabetics more susceptible to alterations in wound healing.

23
Name: Melton, Anna
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Project Category: Biological Sciences and Engineering
Co-Author(s): Riley D. Messman

Effects of vaginal betadine lavages on colostral and neonatal immunoglobulin concentrations

The vaginal microbiota (VM) is the neonate's first contact with microorganisms. Thus, the microbial composition of the VM at parturition attributes to neonatal health outcomes. However, the relationship between an altered VM and neonatal immune response has not been evaluated. Betadine lavages (BL) are used in bovine veterinary medicine to mitigate bacterial infections within the reproductive tract, but this treatment results in massive VM changes. Thus, the objective of this study was to determine if pre-parturition BL impacted passive transfer in neonatal calves. Commercial beef cows and heifers (n = 27) were randomly assigned to either the control group (CON) or the BL treatment group (BTL) two weeks prior to calving. BL bags were prepared with 800mL Lactate Ringer's solution and 200mL of betadine. A sterile infusion pipette infused betadine into the anterior vagina; half of the solution was removed via rectal massage and half was left in the tract for natural expulsion. Cows received 1-3 treatments depending on calving date. Within 24h of parturition, blood samples were gathered from the calf. Blood samples were processed and stored at -80°C. Dam colostrum was collected into a sterile conical tube and stored at -80°C until further processing. All data were analyzed using R software. Colostrum samples were filtered through a sterile 20um filter to remove debris. Both calf serum and dam colostrum were analyzed for immunoglobulin G (IgG) concentration via a commercial ELISA. There was no difference in passive transfer status between CON and BTL calves. There was no significant difference in IgG concentration between CON and BTL calf serum or dam colostrum. Thus, betadine lavages prior to parturition have little effect colostrum IgG concentrations or neonatal passive transfer usage in veterinary medicine. However, a more in-depth study evaluating immune responses and microbial inoculation differences between neonates is warranted.

24
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Project Category: Biological Sciences and Engineering

EEG research for table tennis

EEG testing is a big part of research today. In a study done on golf putting (Babiloniet al 2008), researchers found an increase in cortical activity of alpha and beta waves in the pre-movement period. They also found that in the successful putts, the high-frequency alpha power (10-12 Hz) is smaller in amplitude. Indicating that high-frequency alpha power can predict a golfer's performance. However, there are gaps in this research due to contradicting results from different studies. Further studies will bridge the gaps and be able to give specific information about which brainwaves are active in successful versus unsuccessful actions in sports activities. We will recruit twenty participants with varying levels of experience playing table tennis. We will ask them to participate in a table test experiment to identify what brainwaves are active during success versus failure when they serve a ball to a specific area and when they return a serve to a specific area. Due to the limited testing we have done so far, we do not have specific results. Although some studies have found low alpha power, we predict higher alpha power in frontal lobes during successful serves as higher alpha is indicative of inhibiting the frontal lobes, thus silencing the inner critic- giving the action over to the motor cortex for automatic action execution. Alpha power also relates to relaxation. We further predict that alpha power will be lower when the participant is asked to return the serve because they will have to concentrate and will have to make an in the moment decision requiring more frontal lobe participation. This field of study is important because competition is all around us. Our end goal is to identify the brain correlates of elite performance to inform mental training for performance.

25
Name: Miller, Isaac
Major: Mechanical Engineering
Faculty Advisor Name, Affiliation: Steve Elder, Agricultural and Biological Engineering
Project Category: Biological Sciences and Engineering
Co-Author(s): Ashleigh Nicaise

Injectable in situ forming implant for stable punicalagin release as a disease-modifying osteoarthritis drug

Injectable in situ forming implants have the capacity to hold drug and can release that drug at a sustained rate over periods of weeks to months. The release kinetics of these implants can be manipulated by using different polymers and ratios of different solvents. The purpose of this research is to study in situ forming implants for the release of punicalagin, and to show that punicalagin has disease-modifying properties with respect to osteoarthritis. Punicalagin is a polyphenol derived from pomegranates (*Punica granatum L.*) which contributes to their anti-inflammatory properties, and it is of interest to us because it targets cartilage degeneration *and* synovial inflammation. One aspect of the current project involves creating implants using different polymers (e.g. PLGA 50:50 and PLGA 75:25) and solvents (e.g. N-Methyl-2-pyrrolidone, benzyl benzoate) and determining the punicalagin release kinetics spectrophotometrically. To investigate punicalagin's ability to inhibit collagenase-mediated cartilage degeneration, porcine cartilage explants were incubated in a solution of 0.025 mg/ml collagenase, with and without 100 µM punicalagin. Later, we will test the effects of our punicalagin-releasing implants in the same manner. In addition, an experiment to test punicalagin's ability to suppress LPS-stimulated production of IL-1b from human THP-1 differentiated macrophages is in progress. Results to date show that the release kinetics of the implants can be controlled through concentration of polymer and ratios of solvents for a steady release rate of punicalagin over a month's period. Also, punicalagin was able to substantially reduce the degeneration of cartilage in collagenase. The significance of this research is that there are currently no approved disease-modifying drugs for osteoarthritis. The two most common intra-articularly injected substances are only palliative and abate symptoms temporarily. Thus, there is an urgent, unmet need for disease-modifying osteoarthritis drugs (DMOADs) targeting cartilage and subchondral bone degeneration, as well as synovial inflammation.

26
Name: Miller, Jordan
Major: Agricultural Science
Home Institution (Other than MSU): Alcorn State University
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Project Category: Biological Sciences and Engineering
REU/Research Program: USDA-REEU

Development of lightweight and high-performance wood-based products

Global warming is real and CO2 emissions are the major cause. It is up to us whether we control what we release into the atmosphere. Cement and steel are responsible for 14-16% of global energy-related CO2 emission While wood-based products are carbon negative and renewable materials. However, the better mechanical performance of these large carbon footprint materials compared to wood products cannot be denied. In this project, improving the mechanical performance of wood-based products and reducing the environmental impacts are sought. Profiled structures such as honeycomb and corrugation have resulted in significant advancements in different industries from packaging to aerospace. Wood scientists have adopted this concept to develop wood-based profiled structures. In this technique, wood materials in the form of particles, strands, and veneer are sprayed with a thermoset resin and hot-pressed between a metal matched-die mold, mainly aluminum, into the final geometry. The drawbacks of this technique are costly aluminum mold and CO2 emissions because of consuming energy to cure resin. CO2 emissions because of aluminum production should also not be neglected. To tackle these problems while having the profiled concept to improve the structural performance, a wooden mold was made, and cold-setting resin was used to develop corrugated wood-based panels. Titebond glue was used to bond ten layers of thin veneer to make corrugated panels and three layers of thick veneer to produce flat panels. Corrugated panels were bonded to flat panels on each side using polyurethane resin to make sandwich panels. Flat panels, corrugated panels, and sandwich structures were submitted to bending test to determine improvement in the structural performance.

27
Name: Miller, Taylor
Major: Biochemistry
Faculty Advisor Name, Affiliation: Natraj Krishnan, Biochemistry, Molecular Biology, Entomology and Plant Pathology
Project Category: Biological Sciences and Engineering
Co-Author(s): Caleb Snoddy, Peyton York

Pan-neuronal expression of human ataxin 1 with long polyglutamine repeat (82 amino acids) results in behavioral deficits and neurodegenerative symptoms in Drosophila melanogaster

Polyglutamine (polyQ) diseases are a family of dominantly transmitted neurodegenerative disorders caused by an abnormal expansion of CAG trinucleotide repeats in the protein-coding regions of the respective disease causing genes. Despite their simple genetic basis, the etiology of these diseases is far from clear. Over the past two decades, *Drosophila melanogaster* has proven to be successful in modeling this family of neurodegenerative disorders, including the faithful recapitulation of pathological features such as polyQ length-dependent formation of protein aggregates and progressive neuronal degeneration. In this study, pan-neuronal expression of polyQ was driven using an elav-GAL4 driver line crossed to a responder transgenic fly line expressing human Ataxin 1 with long polyQ repeat of 82 amino acids under control of UAS. This would essentially model the polyQ disease Spinocerebellar ataxia Type 1 (SCA1). Parallel controls were crosses with elav-Gal4 line and UAS responder lines crossed to wild type flies. Additionally, wild type fly Atx-1 was also driven pan-neuronally as an alternative control. Longevity and behavioral analysis of flies expressing human Ataxin1 revealed compromised longevity and disrupted locomotor activity rhythm compared to control flies. Flies expressing human Ataxin 1 also showed enhanced neurodegenerative symptoms with age compared to parallel controls. Taken together, the data indicate that a robust model of SCA1 was created in *Drosophila* which can be effectively used for elucidating the progression of the disease as well as test interventions that may slow the disease progression.

28

Name: Moore, Maggie
Major: Biomedical Engineering
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Project Category: Biological Sciences and Engineering
Co-Author(s): Zack Wallace, Courtney Cates

Developing Cell Culture Models for Obesity Research

Obesity affects everyone, either personally or relationally. Obesity causes innumerable complications, and current treatment options are at best difficult to maintain and at worst ineffective. More effective solutions are vital, but adipocytes tend to float away in cell culture, which hinders the process of studying them in vivo. Our project will seek to extend the longevity of three-dimensional adipocyte culture using surface coatings. Elastin-like polypeptides (ELP), polyethyleneimine (PEI), and Arginine-Glycine-Aspartic Acid (RGD) will be conjugated for different surface coatings. We will use three different coatings: ELP-PEI, ELP-$(RGD)_3$-PEI, and $(RGD)_3$-ELP-PEI. Because of the composition of ELP-PEI, cells form spheroids in culture. Depending on coating's makeup, spheroids become attached for longer/shorter periods of time. The goal of the project is to find a surface coating that tethers our adipocytes to prevent them from floating away. This will allow for better study of adipocyte behavior in the future. Our longest culture period achieved is currently 6 weeks, which is longer than the previous maximum (one to two weeks). Next, we hope to achieve 15 weeks, which will be the first time adipocytes have been cultured for that long. We created the different coatings and used a rapid media change assay to simulate long-term culture. We then used ImageJ to analyze our findings and to quantify the results in order to determine which coating is ideal. The project is still developing, but our current conclusions are that the ELP-$(RGD)_3$-PEI coating provides strong tethering properties.

91
Name: Necaise, Aliyah
Major: Music
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Project Category: Humanities and Arts (Oral Presentation)

The Utilization of the Arts in Teaching Language to Polish and Ukrainian Students

In Poland, learning English is vital for most students in their success academically as well as their career. WIESCO has partnered with X Liceum Ogólnokształcace in Toruń for over 30 years, teaching Polish students English through various classes, discussions, and activities.
Faculty member, Tonya Hays, and I travelled to this camp for the second time since 2019 to teach music, theatre, and other performing arts. There were many challenges due to Covid-19 and the war on Ukraine, but the Polish school administration and Governor's office felt that there was a huge need for this camp because of these factors. These artistic methods of teaching are seldom used in Poland, but we discovered that they are highly effective in their betterment of the English language. However, this summer was different due to the large influx of Ukrainian refugees to Poland. One-third of the students we taught were from Ukraine, who were attempting to juggle learning English as well as Polish. These children were able to flourish with the artistic skills we taught them including dynamics, rhythm, and creative writing. They wrote songs and stories, acted out skits, and finished the camp with a talent show and performance of Shakespeare's *A Midsummer Night's Dream* (Abridged). Many of the students doing these activities and performances would not even speak when the camp began. The arts allowed them to come out of their shells and become more comfortable with the English they knew, while also being exposed to unfamiliar words and styles of speech. In this work the power of the arts to transcend language and cultural differences was evident in the transformation of the students. Music and theatre gave them the confidence to not only speak English but perform and sing in front of their peers, family and invited guests.

29
Name: Paige, She'Kyra
Major: Biological Sciences
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Project Category: Biological Sciences and Engineering
Co-Author(s): Rezwan Tanvir

Expression and putative function of a taxonomically restricted unannotated gene associated with orphan gene QQS

Little is known about the expression and function of the taxonomically restricted unannotated genes associated with the orphan gene *Qua-Quine Starch* (*QQS*). The *QQS* gene can only be found in the plant *Arabidopsis thaliana*. *QQS* modulates the total protein composition of the leaves and seeds of *Arabidopsis* and several other plant species. When overexpressed, the *QQS* gene showed an increase in leaf and seed protein and a decrease in starch. When *QQS* expression was suppressed, one taxonomically restricted unannotated gene, we termed *TRQA* (taxonomically restricted and associated with QQS), was overexpressed. We hypothesized that this gene could be functionally related to the *QQS* gene since their expressions are correlated. Here we have used the GUS reporter system and starch staining to understand the *TRQA* expression, and metabolic changes in *TRQA* overexpression mutants. Preliminary data showed notable expression of *TRQA* in roots and stems but not in the leaf during early stages. However, the expression shifted as the plant matured, and the mature plant had more expression in leaf, stem, and meristem, but no expression was detected in the roots. Our data also showed an increase in starch when *TRQA* was overexpressed. Our study will help better understand the function and expression of the unannotated gene and may help increase plant protein. The outcome of this study may have a significant implication in crop improvement that can help us combat the ever-growing protein deficiency worldwide.

65
Name: Parks, Omri
Major: Chemistry
Faculty Advisor Name, Affiliation: Sidney Creutz, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Ryan Gaynor, Ge Mu

Bioinspired polyimidazole chelates for $Mn2^{+}$ sequestration

Calprotectin is the one of the only known naturally- occurring manganese sequestering proteins in the mammalian immune system. This immunoprotein is responsible for the disruption of homeostasis in bacteria that acquire $Mn2^{+}$ from their hosts for cellular work such as replication, but little has been understood and published on the unique chemistry of this protein. The binding pocket of calprotectin contains a hexahistidine site that has a strong affinity for $Mn2^{+}$ chelation. There is a need for more high metal affinity ligands that mimic the binding properties of calprotectin to understand how it achieves this high $Mn2^{+}$ affinity. Herein we report the synthesis and quantitative analyses of polyimidazole ligands that mimic the calprotectin binding pocket. The future aims are to further quantify these targets and test their antibiotic activity for a more in-depth understanding of their biological mechanisms.

30
Name: Patrick, Hunter
Major: Biological Engineering
Home Institution (Other than MSU): North Carolina State University
Faculty Advisor Name, Affiliation: Yunsang Kim, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
Co-Author(s): Shuaib A. Mubarak
REU/Research Program: USDA-REEU

Cellulose and chitin nanofibers stabilized Pickering emulsion encapsulating a phase change material

Phase change materials (PCMs) are promising materials for storing and releasing energy. However, their application is often limited by volatility and reactivity, which requires the stabilization of PCMs. In this work, *n*-hexadecane as one of the PCMs was microencapsulated through an oil-in-water Pickering emulsion method with 0.3 wt% cellulose nanofibers (CNF) in water. Chitin nanofibers (ChNF) in an aqueous suspension (0.3 wt%) was later added to the CNF-based emulsions, aiming to enhance the stability of the CNF-based emulsions by means of the charge-driven assembly of nanoparticles. The mass ratios of ChNF to CNF were 0:10, 3:7, 5:5, and 7:3. The CNF-stabilized oil-in-water Pickering emulsions composited with ChNF was characterized by using optical microscopy, confocal laser scanning microscopy (CLSM) and thermogravimetric analyzer (TGA). The results from the optical microscopy showed that the size of the microcapsules (with an average diameter of 10 μm) did not change significantly with the addition of ChNF. TGA data indicated the microcapsules containing ChNF showed higher thermal stability compared to the CNF-only microcapsules. From CLSM images, the *n*-hexadecane core labelled with Nile red was seen forming spherical droplets, indicating the encapsulation of the PCM into the microcapsule. ChNF-CNF/PCM composite microcapsules can be an ideal candidate for smart textiles, smart buildings, batteries, and electronic devices due to their sustainability and impressive thermal regulating properties.

66
Name: Pearce, James
Major: Chemistry
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Project Category: Physical Sciences and Engineering
Co-Author(s): Samuel D. Juárez-Escamilla

Synthesis Pincer Complexes of the Group 6 Metal Molybdenum

Molybdenum complexes in nature have been found to catalyze nitrogen fixation. Nitrogen fixation is an important process in the generation of fertilizer and synthetic precursors to many biologically active molecules. The Haber-Bosch process is the most widely used industrial method of nitrogen fixation used today. This process requires significant amounts of heat and pressure and releases a considerable quantity of greenhouse emissions. The process is dependent on CH_4 as a hydrogen source, releasing CO_2 as a byproduct. The large amount of energy needed to reach the necessary temperatures and pressures at an industrial scale also accounts for a large portion of the emissions. A more efficient catalyst would be of great agricultural importance. A complex that could be used in this process was synthesized. *N*-heterocycle carbene (NHC) pincer complexes of molybdenum have been shown to catalyze nitrogen fixation. Our goal is to create a more efficient nitrogen fixation catalyst from an CCC-NHC molybdenum pincer complex. The target of this project is to achieve nitrogen fixation at a temperature and pressure reasonably close to ambient conditions, while maintaining an efficiency comparable to existing catalysts. The first stage of the project involves the synthesis of the CCC-NHC molybdenum complex that will be used as a precatalyst. Afterwards, the behavior of the Mo complex in different solvents and in different chemical environments will be studied. A CCC-NHC zirconium complex, originally synthesized by the Hollis group, was used in transmetallation reactions with various molybdenum sources. Catalytic testing of these molybdenum compounds will be the subject of future research. The latest results attempting to obtain a high yielding synthesis of the CCC-NHC pincer Mo complex will be reported.

84
Name: Perkins, Maxwell
Major: Business Information Systems
Faculty Advisor Name, Affiliation: Sujan Ranjan Anreddy, Social Science Research Center
Project Category: Social Sciences

Analyzing Machine Learning Algorithms for Classification of COVID-19 Misinformation across Social Media Platforms

Distrust in the scientific community during the COVID-19 pandemic augmented urgent public health concerns through fostering the spread of misinformation on social media platforms. Uncertainty surrounding the appropriate remedies for the virus led many to promote misinformation that deepened distrust in scientists and further obfuscated appropriate procedures. To combat this misinformation, some platforms implemented moderation procedures which included flagging or removing posts that could contain misinformation. With the goal of combating the spread of misinformation across multiple platforms, this study analyzes machine learning algorithms for predicting COVID-19 related misinformation in text-based social media posts. Multinomial Naive Bayes (MNB), Support Vector Machines (SVM), and Multinomial Logistic Regression (MLR) are some of the Natural Language Processing (NLP) text-classification algorithms implemented and compared for identifying misinformation. To train and test the prospective models, data related to COVID-19 was collected from Parler, Reddit, Tumblr, Twitter, and YouTube Comments. Algorithm performance is evaluated through comparison between expected performance percentages from the sample and resulting predictions on the population data. So far, algorithm performance measures indicate that a Support Vector Machine algorithm is adept at identifying posts with misinformation from across the given social media platforms, in comparison with the aforementioned algorithms. With further tuning for certain platforms an SVM algorithm has potential to be a credible filter for consumption of COVID-19 related social media information.

67
Name: Raderstorf, Christine
Major: Mathematics
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Faculty Advisor Name, Affiliation: Vu Thai Luan, Mathematics and Statistics
Project Category: Physical Sciences and Engineering
Co-Author(s): Hoang Nguyen
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Innovative Time Integration Methods for Epidemics and Genetics

Mathematical models are commonly utilized in the field of epidemiology to predict the trends and progression of a disease. With the rise of Covid-19 over the past two years, nations worldwide have worked to develop models to track the pandemic and aid policy makers in developing guidelines to slow the spread of the virus. These models are commonly systems of nonlinear ordinary differential equations that use numerical approximation techniques as opposed to exact solutions. The type of numerical approximation method used can have a large effect on the accuracy, positivity, mass conservation, and long-term stability of the model. In this research study, we have examined an expanded SIR model called SIDARTHE developed in Italy in early 2020. The model uses the forward Euler method, a simple method that preserves mass but becomes unstable and inaccurate fairly quickly. We have found that it is only of first-order accuracy, has to use a small time-step due to the stability restrictions, and does not preserve positivity unconditionally. We then propose a reformation of the model to utilize alternate numerical approximation methods, namely the backward Euler method and exponential methods of first and second-order accuracy, to overcome these shortcomings. In particular, using these proposed methods, we were able to produce the same results in terms of accuracy as the original model while using a much larger time-step, thereby increasing the computation efficiency when compared to the original method. We hope that the results from the research can be incorporated into future model developments.

31
Name: Ray, Jordan
Major: Pre-Veterinary Medical Tech
Faculty Advisor Name, Affiliation: Molly Nicodemus, Animal & Dairy Science
Project Category: Biological Sciences and Engineering
Co-Author(s): Molly Friend, Rebecca Swanson
REU/Research Program: College of Agriculture and Life Sciences URSP

Human-Horse Interaction: How horses can benefit college students through equine assisted psychotherapy and learning programs

Overdose is the number one killer in college-aged young adults. During the COVID-19 Pandemic, a rise in substance abuse was documented, particularly in young adults, and as students in the past year attempted to return back into normal college life on campus, many students faced difficulties with the transition to campus exacerbating their struggles with mental health. To assist with this transition back on campus, colleges have turned to animals finding human-animal interactions have a therapeutic benefit for young adults. Therefore, the objective of this study was to determine the benefits of horse interaction for college students participating in an equine assisted psychotherapy and learning program. Young adults (age: 18-21 years old; n=3) enrolled full time at a Mississippi college were recruited to participate in a two-week on campus equine assisted psychotherapy and learning (EAPL) program. Before and after the one-hour EAPL session each week, human participants completed a survey evaluating emotional health and equine knowledge, and to determine potential human-horse physiological coupling, human and horse heart rates, cortisol levels, and pain scales were measured. While anecdotally participants reported a more positive attitude after completing the sessions, due to the limited sample population and the sessions restricted to only once a week for two weeks, no significant differences were found between measurements taken ($P>0.05$). Nevertheless, despite the limited benefits reported at this time, further research concerning the benefits of EAPL specific to mental health disorders within college-aged young adults should be explored as this research can assist in development of effective campus-based EAPL programs.

32

Name: Richardson, Chloe
Faculty Advisor Name, Affiliation: Jagman Dhillon, Plant and Soil Sciences
Project Category: Biological Sciences and Engineering
Co-Author(s): Camden Oglesby

Effect of Nitrogen and leaf orientation on the chlorophyll content of corn

Inaccurate corn seed placement can result in suboptimal corn leaf orientation. Asymmetrical leaf positioning and leaf overlap can turn impact chlorophyll content and grain yield, due to uneven light interception. This study aimed to measure the effect of nitrogen (N) and natural leaf orientation on the chlorophyll content of corn in Mississippi. An existing N rate field experiment in Starkville, Mississippi was selected to test this hypothesis. Two factors including three N rates (0, 135, and 270 kg N ha^{-1}) and two leaf orientations [0^o (perfect leaves) and 90^o angle (overlapped leaves)] were selected, where treatments were replicated four times in a randomized complete block design. A SPAD chlorophyll meter was used to estimate the chlorophyll content of each treatment at V7 (seven leaves), V8 (eight leaves) and VT (tasseling) growth stages. Overall, only N rate significantly affected chlorophyll content, where SPAD values increased and plateaued at 135 kg N ha^{-1}. However, mean separation revealed that at the V8 growth stage with 135 kg N ha^{-1} application and 0^o orientation a significantly higher SPAD value was produced compared to the 90^o orientation. These results diminish as the season progressed. Although SPAD values did not reveal significant differences due to leaf orientation, the final yield may be affected which will be evaluated at the completion of the growing season.

33
Name: Ross, Angela
Major: Biochemistry
Faculty Advisor Name, Affiliation: Russell Carr, Comparative Biomedical Sciences, Center for Environmental Health Sciences
Project Category: Biological Sciences and Engineering
Co-Author(s): Kylee J. Burroughs, Shirley X. Guo-Ross, Katelyn N. Sette, Caera A. Taylor

Sex Differences in the Effect of Cannabidiol on the Innate Immune Response in the Brains of Juvenile Rats

Cannabidiol (CBD) is a naturally occurring compound found in the *Cannabis sativa* plant. Although CBD has been shown to alleviate seizures in children, its efficacy in other ailments such as depression, anxiety, and ADHD is still inconclusive. However, anecdotal evidence suggests that CBD is being administered by parents to their children to reduce hyperactivity and impulsivity even in the absence of an ADHD diagnosis. It is known that CBD has anti-inflammatory properties, and it is possible that CBD exposure could alter the response of the innate immune system in the brain of juveniles exposed to CBD. To explore this, 12-day-old male and female Sprague-Dawley rats were orally administered either corn oil (vehicle control), 20 mg/kg CBD, or 60 mg/kg CBD for 5 consecutive days. One hour after the last CBD treatment, the viral mimic Resiquimod R848 (2.5 μg/g) was administered intranasally to challenge the rat's immune system. Brains were collected 6 hours after the R848 challenge, total brain RNA was extracted, and RT-qPCR was performed to measure mRNA expression of markers for activation of astrocytes (GFAP and S100β) and microglia (Iba-1 and TMEM119). Following R848 challenge, TMEM119 expression was decreased in both sexes, whereas Iba-1 expression was decreased in males and slightly increased in females. CBD treatment had no effect on this gene expression pattern. Expression of GFAP was increased in both sexes following the R848 challenge, and 60 mg/kg CBD reduced the increase in GFAP expression in males but not in females. Expression of S100β was variable in all treatment groups with no distinct pattern. These data suggest that in juvenile rats, sex differences may exist in the sensitivity of astrocytes and microglia to the exposure of CBD, and this could alter their response to a pathogenic challenge.

68
Name: Rouse, Emily
Major: Chemistry
Home Institution (Other than MSU): Lebanon Valley College
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Project Category: Physical Sciences and Engineering
Co-Author(s): Mitu Sharma, Alison K. Duckworth
REU/Research Program: NSF-INFEWS

Metal N-Heterocyclic Carbene Complexes as Catalyst for Ketone Reduction Reactions

N-heterocyclic carbenes (NHCs) are strong σ-donating ligands that coordinate to a range of metal ions, which can serve as powerful catalysts for modern organic transformations. NHCs offer some benefit over other common organometallic ligands like the phosphines, which typically show limited air and moisture stability. Nickel(II) complexes of both imidazole and benzimidazole based NHCs have been synthesized and characterized, and show moderate reactivity toward acetophenone to generate 1-phenylethanol. Other first-row transition metal ions (including Mn^{2+}, Fe^{2+}, Co^{2+}, Cu^{2+}, and Zn^{2+}) have also been explored, toward the efficient reduction of ketone in sustainable solvents. This Lewis acid catalyzed conversion of ketones to alcohols provides opportunities for further method development that can be used in modern synthetic processes. Characterization of the NHC complexes were done by UV-vis, X-ray crystallography, and HR-MS and the reaction products were analyzed by GC-MS, thin layer chromatography, and LC-MS.

69
Name: Russell, Liv
Major: Mechanical Engineering
Faculty Advisor Name, Affiliation: Matthew Priddy, Mechanical Engineering
Project Category: Physical Sciences and Engineering
Co-Author(s): Matthew Register, David Failla

Feasibility and Limitations of Finite Element Modeling of Wire Arc Additive Manufacturing
Traditional additive manufacturing (AM), though it has revolutionized prototyping and small batch manufacturing, is geometrically limited in producing parts with overhangs. Wire-arc additive manufacturing (WAAM) and other 5-axis AM remove these limitations by rotating both the workpiece and the heat source, allowing for more complex geometries. However, rotating the heat source introduces new thermal variability as old material is reheated in varying directions rather than just downwards into the bed. The effects of these temperature cycles are not well known. This work focuses utilizing finite element (FE) simulations of 5-axis material deposition processes for predicting thermal and mechanical variabilities to better understand and utilize 5-axis AM. Though FE methods are widely used for modeling 3-axis processes, they are yet to be openly utilized in literature for 5-axis processes. A geometry that requires 5-axis manufacturing is modeled to prove the feasibility of such simulations. Then, utilizing a geometry that could be produced with either manufacturing method, simulations of 3-axis and 5-axis AM processes will be compared to illustrate the differences in thermal history. Additionally, current limitations in creating 5-axis simulations will be explored, such as the lack of any framework for tool path and material deposition event series creation.

92
Name: Sanders, Mary
Major: Art
Faculty Advisor Name, Affiliation: Soon Ee Ngoh, Art
Project Category: Humanities and Arts (Oral Presentation)
Co-Author(s): James Karlson
REU/Research Program: ORED Undergraduate Research Program

Representing subjects of scientific study through artistic expression. An effort to bridge the artistic and scientific community at MSU

The Biology Department seeks out prospective arts students to collaborate on an on-going mural project. This is the third completed mural inside of Harned Hall. While these murals are pieces of artistic expression, the department desired that they reflect the current research conducted by the faculty members residing on the respective floors. The murals span a four-part wall section that measures ~7 feet high and a total of 16 ½ feet long. The faculty provided us with research materials that we used as reference and inspiration for our design. This correspondence with the faculty developed the primary ideas for the theme concept of the mural. Dr Welch and team study rock iguanas as well as conduct experiments with various fauna including sunflowers. Both Dr. Ballinger and Dr.Thornton work in microbiology specializing in the study of a specimen known as the spiroplasm. These areas of research all had strong visual pulls to them. The plant life and iguanas bring a variety of textures, shapes, and colors to the scene. The microbiology elements were abstracted into geometry that adds depth to the fore and background. Various technologies and techniques were applied to achieve the overall success and drafting of the finished mural. Traditional sketch paired with photo manipulation software and projection technologies allowed us to take an artistic rendering and transform it into a visual experience. The mural truly pays respect to the specimens that inspired it, anyone viewing the work should be reminded how beautiful biology is and the efforts employed to study and showcase it.

70
Name: Schina, Madelynn
Major: Mathematics
Home Institution (Other than MSU): Stockton University
Faculty Advisor Name, Affiliation: Tung-Lung Wu, Mathematics and Statistics
Project Category: Physical Sciences and Engineering
Co-Author(s): Albert Jackson
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Entropy-Based Anomaly Detection in Nanofibrous Materials

Nanofibrous materials are becoming increasingly important within the field of medicine due to its large number of applications. In an effort to increase the supply, companies are making strides to optimize and upscale the production process. Although there are multiple techniques for producing nanofibers, researchers have found electrospinning to be the most promising prospect. In order to improve the system, the presence of defects like clusters and beads need to be identified. The aim of this project is to develop a program that will identify normal SEM images of nanofibrous materials based off anomalous SEM images. After being translated into matrices, provided images will be converted to a black and white scale. The program will then use a specified window to scan the image and calculate the entropy of each individual section. The entropies are then compared to a critical value of 0.367 which was determined from previous trials. This comparison will indicate if a defect is present in that image. The algorithm has been successfully coded and more images are being used to test its accuracy. Future work on this project looks to improve the program's accuracy and efficiency by altering set parameters.

71
Name: Schuetzle, Ethan
Major: Mechanical Engineering
Faculty Advisor Name, Affiliation: HeeJin Cho, Mechanical Engineering
Project Category: Physical Sciences and Engineering
Co-Author(s): Gentry Berry

Evaluation of Methods for Obtaining Filter Media Fiber Diameter

One of the major challenges presented in nuclear waste management is the filtration of contaminated air. Nuclear facilities commonly use High Efficiency Particulate Air (HEPA) filters as the last line of defense to contain airborne waste due to the balance between resistance to airflow and high efficiency filtration (e.g., 99.97%) that they provide. Theoretical models used to predict the filtering efficiency and the pressure drop across filters show that the filtering efficiency and initial pressure drop across a clean filter is a function of the fiber diameters of the filter media. Three methods to determine the filter media fiber diameter were investigated: an algorithmic method, a manual method, and a hybrid method. The research determined whether the change in accuracy of measurements due to utilizing more intensive methods merits the effort required to perform them. By incorporating Scanning Electron Microscope (SEM) image analysis alongside an image processing program known as ImageJ and a plugin called DiameterJ, statistical data such as fiber diameter unique to each image can be readily gathered. This is achieved by analyzing images of filter media taken by the SEM, utilizing all three methods for each image. The fiber diameter values obtained from each method are used to calculate the pressure drop and filtering efficiency of the clean filters. The resulting pressure drop and filtering efficiency values obtained from the various estimated fiber diameter values are then compared and analyzed. This reveals the sensitivity of the filtering efficiency and pressure drop equations to the change in fiber diameter resulting from the incorporation of the three measurement methods. Upon conclusion of this study, the data gathered will be discussed along with any implications it may carry.

72
Name: Singh, Sukhvir
Home Institution (Other than MSU): University of Maryland, Baltimore County
Faculty Advisor Name, Affiliation: Virginia Montiel-Palma, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Miguel Cabrera Briseno
REU/Research Program: Food, Energy, and Water Security

Synthesis and Characterization of Nickel Organometallic Complexes using PSiH and PGeH Ligands

Nickel is a transition metal that is abundant, low cost, and easy to handle. These factors make nickel ideal for creating organometallic complexes used for catalysis. PSiH is a bidentate ligand that is can be used to bind onto the transition metal center to build an organometallic complex. We will be utilizing PSiH and its derivatives to synthesize new nickel complexes using precursors such as $[Ni(COD)_2]$, $[Ni(PPh_3)_4]$, and $[NiCl_2(PPh_3)_4]$. We speculate that other elements in the same group as silicon could act as effective ligands on transition metals. One example of a new ligand that can be made is using germanium, forming PGeH analog. Whether the synthesis of PGeH is possible and if it can bind to nickel is unknown. First, the synthesis of the PGeH was pursued. We confirmed that the synthesis of PGeH was successful, however further research in the synthesis process is required to increase its yield. To test if the new nickel organometallic complexes could be synthesized, a variety of nickel precursors were used with PSiH. We found that PSiH was successful in bonding to the nickel precursors to form the desired organometallic complexes. The confirmation for the synthesis of both the ligand and the complexes was characterized via ^{1}H NMR and ^{31}P NMR. We conclude that the synthesis of the ligands in the same group as silicon is possible and that new nickel complexes were produced. Nickel complexes are effective catalysts in hydrogenation, our future endeavors will test the reactivity of the newly synthesized nickel complexes in the hydrogenation of phenylacetylene.

85
Name: Sloan, Jessie
Major: Educational Psychology
Faculty Advisor Name, Affiliation: Kasia Gallo, Counseling, Educational Psychology, and Foundations
Project Category: Social Sciences

Obstacles to Women in Ministry: A Manifestation of Gender Stereotyping

The following literature review examines the gender stereotypes women face in leadership positions, specifically focusing on the context of church leadership. Gender stereotyping can be defined as what people believe a person can and cannot do based on their gender. Women who hold leadership positions in churches, such as pastors or ordained clergy positions, face obstacles in their careers, and some of these obstacles are related solely to their gender. Obstacles include but are not limited to, feeling like they have to work twice as hard to receive the same respect as a male pastor, being passed over for advancement, and the pressure of being a good enough example to help other women also be allowed to lead. These issues also affect women in leadership beyond the context of church ministry. Fifteen empirical journal articles were examined about women in church leadership, women in leadership, and gender stereotypes. Clergymen, clergywomen, college students, and the general public were participants in these studies. Participants are from diverse geographical regions from the United States and other countries. Data were gathered through open-ended interviews, various scales, and situational examples. These studies reported that women face consistent and persistent obstacles as leaders, in the church field and beyond. These obstacles are due in part to the gender stereotypes held by both men and women. Specific action needs to be taken to address and overcome these stereotypes in order to promote and encourage women to become leaders.

86
Name: Smith, Courtney
Major: Kinesiology
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Project Category: Social Sciences

Cognitive Functioning in Older Adults with Hoarding Disorder

Purpose: The purpose of this study was to examine neurocognitive functioning in older adults with hoarding disorder. Clutter tends to increase with age. Older adults with cognitive impairment may especially susceptible to issues with clutter and treatment engagement.
Method: Thirteen older adults enrolled in a pilot treatment study for hoarding disorder completed the NIH Cognition Battery during their baseline assessment. All assessment procedures took place in participants' homes. The NIH Cognition Battery was administered using an iPad and includes measures of executive function, attention, episodic memory, language, processing speed, and working memory. Raw scores were transformed into T-scores correcting for age and education.
Results: Participants' average scores on the NIH Cognition Battery domains were all within one standard deviation of the mean, with the exception of participants' scores on a task of Attention (average T score = 39; standard deviation = 7.9, range 26-55). However, a notable percentage of participants scored less than one standard deviation below the mean on several tests (54% on Attention; 23% on Executive Functioning; 38% on Episodic Memory; 54% on Processing Speed; 8% on Language; 23% on Working Memory).
Conclusion: Attention and processing speed were the two domains where participants demonstrated the most impairment. This may impact participants' ability to engage in treatment by hindering their engagement within session. Participants with low levels of attention may need additional assistance to focus in session and for scheduling. Older adults in treatment for hoarding disorder may benefit from repeated instructions and a slower pace of intervention.

73
Name: Smith, Ethan
Major: Physics
Faculty Advisor Name, Affiliation: Sanghwa Park, Physics & Astronomy; Ciprian Gal, Physics & Astronomy
Project Category: Physical Sciences and Engineering

Compton Polarimetry in the Electron-Ion Collider

Electron polarimetry is to be an essential part of the next-generation nuclear facility, the Electron-Ion Collider (EIC). The EIC will facilitate the unparalleled study of the internal structure of the proton by creating high-energy interactions between a stream of electrons and a stream of deshielded protons. Within the particle accelerator, a Compton polarimeter will be stationed to measure and monitor the polarization of the electron beam by colliding constituent electrons with photons to produce an effect known as Compton scattering. The physical quantities observed in the scattering will correlate to the electron beam's degree of polarization, rendering that polarization directly measurable. Since the EIC necessitates that polarization measurements be significantly more accurate than 1%, a fast-pulse laser system has been proposed, and an autocorrelator was designed and assembled to measure these short pulses. The autocorrelator splits the original pulse into two identical beams which are then superimposed with variable temporal difference. The resulting interactions produce measurable signals, allowing quantities such as pulse duration to be retrieved. Additionally, since the sensitivity of the polarimeter itself crucially depends on the properties of the electron and photon beams, simulation studies were performed. Three simulations of Compton interactions were produced: the first assumed infinitely focused beams, while the second assumed a realistic electron beam size and a large laser beam size, and the third assumed a realistic electron beam size and a realistic laser beam size. With these simulations, the impact on the sensitivity of the system was analyzed, the results of which proved the proposed laser system adequate.

74
Name: Sullivan, Emily
Major: Biochemistry
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Faculty Advisor Name, Affiliation: Todd E. Mlsna, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Hashani P. Abeysinghe, Prashan M. Rodrigo, Charles U. Pittman Jr.
REU/Research Program: INFEWS

Remediation of Aqueous Arsenic (V) by Iron Oxide/Rice Husk Biochar Composite

Arsenic is a natural component of the Earth's crust and is widely distributed naturally and anthropogenically throughout the environment. Inorganic arsenic contamination in groundwater throughout the world has threatened public health due to its toxic and carcinogenic nature. It is a confirmed Group I carcinogen by the International Agency for Research on Cancer. The consumption limit of arsenic for safety standards from WHO is 10 μgL^{-1}, but certain areas of the world have natural contamination levels exceeding this amount. As(V) is the predominant species present under oxidizing conditions and exists as oxyanion forms with $H_2AsO_4^-$ and $HAsO_4^{2-}$ as the most dominant species. Many researchers have reported rice husk biochar as a cost-effective, easily accessible sorbent for removing contaminants from water. This study involves the synthesis of magnetized biochar from raw rice husk to remediate As(V) from water and the elucidation of the possible mechanisms and binding interactions between adsorbate and adsorbent. Magnetized rice husk biochar was prepared by loading biochar with $FeCl_3$ followed by adjusting the pH to 10 prior to the pyrolyzing at 600 °C for an hour. As(V) adsorption features were determined in numerous studies including analyzing the influence of pH (analyze optimum pH), isotherm capacities (investigate the effect of initial concentration of adsorbate and temperature), kinetics (explore optimum adsorbent/adsorbate contact time), impact of competitive ions, and a column adsorption study. This sorbent was characterized using XRD (X-ray diffraction), XPS (X-ray photoelectron spectroscopy), SEM (scanning electron microscopy), TEM (transmission electron microscopy), FT-IR (Fourier transform infrared spectroscopy), BET (Brunauer−Emmett−Teller) measurement, and PZC (point of zero charge) and a regeneration study. The results of this study will be used to optimize the remediation of As(V) from wastewater for optimum environmental utilization of this biochar.

75
Name: Thurmond, Kaitlyn
Major: Physics
Home Institution (Other than MSU): University of Mississippi
Faculty Advisor Name, Affiliation: R. Torsten Clay, Physics & Astronomy
Project Category: Physical Sciences and Engineering
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Cooperative Versus Competitive Mechanisms of Unconventional Superconductivity

More than 35 years after the discovery of the high critical temperature cuprate superconductors, their mechanism of superconductivity is still not understood. In the cuprates and other unconventional superconductors, a pairing of electrons occurs within two-dimensional layers. In two dimensions (2D) interactions between electrons become significant and are believed to play a critical role in superconductivity, unlike in low-temperature superconductors where the electron-lattice (e-l) interaction provides the effective attraction for Cooper pair formation. The effect of e-l interactions alone, and especially the effect of electron-electron (e-e) and e-l interactions combined, has not been studied in detail in 2D. We computationally study a combined version of the Hubbard model and the Su-Schrieffer-Heeger model in 2D here referred to as the tUW model. The tUW model includes the kinetic energy of electrons (t), a short-range repulsive e-e interaction (U), and a simplified e-l interaction term (W). Previous work on the tUW model showed that at an electron density of one electron per site (<n>=1), the U and W terms are competitive, with W favoring superconductivity but U causing insulating behavior. Here we focused on smaller densities where the model has not been studied. Our results show that away from <n>=1, isotropic (s-wave) superconductivity is cooperatively enhanced by both U and W and is therefore dominant for large values of W. For more realistic parameters (moderate to large U and small W), d-wave pairing was stronger. However, the strength of d-wave pairing in the model sensitively depends on the values of U and W as well as the lattice structure.

76
Name: Toth, Elizabeth
Major: Biochemistry
Home Institution (Other than MSU): Taylor University
Faculty Advisor Name, Affiliation: Benjamin Crider, Physics & Astronomy; Ronald Unz, Institute for Clean Energy Technology
Project Category: Physical Sciences and Engineering
Co-Author(s): Jaime Rickert
REU/Research Program: INFEWS: Food, Energy, and Water Security

Deficiencies in Dose Rate Detector Response Measurements for Scintillation Detectors Used in Radiological Surveying Systems

The *Multi-Agency Radiological Survey and Site Investigation Manual* (MARSSIM) is a manual that guides nuclear site managers through the process of planning, remediating, and providing evidence for license termination. MARSSIM defines the minimum detectable concentration, or MDC, which is the minimum amount of radioactive material that can be statistically segregated against background radiation. The derived concentration guideline (DCGL) is the site-specific maximum limit of residual contamination allowed to be left behind after remediation. It is necessary for the MDC to be below the DCGL to ensure that all residual contamination is removed. The United States Nuclear Regulatory Commission Regulation report 1507, *Minimum Detectable Concentrations with Typical Radiation Survey for Instruments for Various Contaminants and Field Conditions* (NUREG-1507) outlines how MDCs are to be calculated. Radiation detectors each have their own intrinsic physical properties that can affect the MDC calculations. These affect the detector's response and sensitivity. Point-kernel models used to calculate dose rates for specific detector-source geometries assume a point detector, but all detectors have a solid angle subtended from the source and volume, which in turn differs from point-kernel models; therefore, measurements have a larger absorbed dose than the point-kernel model estimates. Additionally, it is standard for detectors to be characterized/calibrated in a room with minimum dimensions of 4 m by 4 m by 3 m structure to minimize gamma ray interactions within the calibration room's walls, floor, and ceiling, which can distort detector response measurements. This work describes the characterization of the detector response of large-volume scintillation detectors in a non-uniform radiation field. It was identified that the detector response measurements are highly impacted by the detector-source geometry, which are essentially not addressed in MARSSIM/NUREG. This work identifies the need for more advanced dose rate models for large-volume detectors in non-uniform radiation fields.

34
Name: Truong, Van
Major: Environmental Economics & Sustainability
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Project Category: Biological Sciences and Engineering
Co-Author(s): Raju Bheemanahalli

Waterlogging Effects on Cotton Growth, Physiology and Hyperspectral Properties

Waterlogging is one of the main abiotic stresses that limits plant growth and development. Changes projected in climate will drive increased frequencies of extreme climatic events, including waterlogging in major crop production areas. There is little information on whether the cotton crop will respond to waterlogging during the early season. To improve the ability of crop models to estimate crop growth and development under soil waterlogging stress reliably, we experimented with two-leaf stage cotton cultivar DP 1646 B2XF by varying the duration of waterlogging from 0 to 14 days with two-day intervals. Soil oxygen levels, gas exchange traits, leaf temperatures, pigments, and flavonoids were measured every two days. The whole plant leaf area and plant component dry weights were measured at the final harvest. In addition, leaf hyperspectral properties were measured to identify spectral properties of waterlogged plants. Cotton vigor in terms of stem length, the number of leaves, leaf area, and whole plant- and plant-component dry weights declined with days of waterlogging. Plants with extended waterlogging showed hypertrophic lenticels, visible leaf scorching, lower chlorophyll pigments, and increased flavonoids. A significant decline in several root traits was observed under waterlogged conditions. The functional relationships between waterlogging duration and cotton growth and development will be helpful in improving the functionality of cotton models for field application. In addition, leaf hyperspectral image analysis will be a step forward in identifying sensitive wavebands for waterlogged conditions. Further studies are needed to understand the genetic variability under waterlogged conditions and at different growth stages.

35
Name: Turo, Ethan
Major: Sustainable Bioproducts
Faculty Advisor Name, Affiliation: Frank Owens, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
Co-Author(s): Brunela Pollastrelli Rodrigues, Alex C. Wiedenhoeft
REU/Research Program: USDA-REEU

Evaluating the Effect of a Lower Resolution Camera on Computer Vision Wood Identification with the XyloTron

Computer vision wood identification (CVWID) systems have the ability to provide accurate and reliable identification that is affordable and field deployable. Of these systems, the Xylotron (XT) platform, created by the USDA Forest Products Laboratory, has been used in a recent study to develop a high-performing model for Peruvian timbers. Since its inception, the XyloTron has come with a Flea3 camera (2048 x 2048 pixel resolution) until the recent discontinuation of this line of cameras. The BlackFly camera is a drop-in replacement with a lower resolution (1328 x 1328 pixels) than the Flea3 camera. The goal of this study is to test how the XyloTron equipped with the new BlackFly camera and lower resolution performs using models developed with the XyloTron with the higher resolution Flea3 camera. Using a data set of 119 specimens from the PACw xylarium from Mississippi State University, images will be taken of the samples using each camera, and the identification accuracy of the two cameras will be compared. The expected result for this study is that, despite imaging at a lower resolution, the XyloTron equipped with the BlackFly camera will have similar accuracy results to the XyloTron equipped with the older Flea3 camera. This study sets out to improve and advance CVWID technology for real-world applications by potentially decreasing computational cost using lower resolution images.

36
Name: Vann, Ryan
Major: Biological Engineering
Home Institution (Other than MSU): North Carolina State University
Faculty Advisor Name, Affiliation: Yunsang Kim, Sustainable Bioproducts
Project Category: Biological Sciences and Engineering
Co-Author(s): Hamed Olayiwola
REU/Research Program: USDA-REEU

Creation of Biodegradable Preservatives Through Use of Essential Oils

In order to explore alternatives to modern artificial wood preservatives, this study examined the viability of utilizing essential oils as a natural wood preservative. This goal was accomplished by attempting to formulate an inclusion complex encapsulating thymol in the cavity of β-cyclodextrin (βCD). This complex was formulated through dissolving βCD in water and adding thymol to the aqueous βCD solution, followed by running the mixture through an ultrasonication device inside of an ice bath in order to prepare a thymol-βCD inclusion complex, which was centrifuged and freeze dried for further analysis. The resulting complex was analyzed via FTIR and UV-VIS spectroscopy to confirm both the presence of thymol inside the complex as well as to estimate the inclusion yield of thymol in the complex. Our analysis indicated the process yielded 45% thymol encapsulated inside the βCD complex. Moreover, the inclusion yield marked 113% and 100% in 5 times and 10 times large batch sizes, respectively, which suggests reproducibility of the production of thymol-βCD inclusion complex. Given such high yields at the increased production level, it can be determined that this method successfully encapsulates thymol inside the complex at an acceptable rate, and could be used in the future as a biodegradable wood preservative.

77
Name: Vaughan, Leah
Major: Electrical Engineering
Faculty Advisor Name, Affiliation: Samee Khan, Electrical and Computer Engineering
Project Category: Physical Sciences and Engineering

The development of a UAS integration safety and security data ontology
This research will support the development of cross-agency standards against which to test prospective UAS integration safety and security technologies. A subsection of this research is the creation of an ontology. An ontology is a taxonomy in the semantic web, a hierarchy of terms linked together with relationships that help define these terms and provide an underlying logic. The Semantic Web is a web of connected data and technologies that allow machines to read and store this data, build vocabulary, and handle rules associated with the linked data. The application, Protégé, was used to create the ontology using the coding language ontology web language (OWL). OWL is a Semantic Web language using description logic, which is a family of knowledge representation languages that allows greater machine interpretation. This will be achieved by using the top-down methodology. First, defining the scope, purpose, main ideas, and topics. Next, researching useful external ontologies and resources for the development of local ontologies. After that, the progress in the operational data store (ORDS) development will be significant, which is a centralized database from multiple sources. These steps will result in the integration of external and local ontologies, a resulting taxonomy, and early evaluations.

78
Name: Villalobos, Gerardo
Major: Mathematics
Home Institution (Other than MSU): The University of Texas Austin
Faculty Advisor Name, Affiliation: Hyeona Lim, Mathematics and Statistics
Project Category: Physical Sciences and Engineering
Co-Author(s): David Hernandez (University of Central Florida), Shiraz Mujahid (Mississippi State University)
REU/Research Program: REU in Computational Methods with Applications in Materials Science

Exploration and Development of Image Denoising Techniques for Color Images

Images are invaluable tools to capture data and by extension it is important that noise in the image that obscures the data we wish to analyze is minimal. In our study, we explore different conventional image denoising approaches varying from total variational techniques and non-local means (NLM) filter methods. This is in efforts to develop new algorithms that aim to improve the accuracy and efficiency of the conventional methods. With variational and NLM being the two major approaches towards grayscale image denoising, the present study proposes modifications to extend these methods to color images. These include the simultaneous application of NLM and variational denoising, examination of interdependencies between color channels, and k-means clustering. One model involves the successive application of improved total variation and NLM to each color channel separately. Another approach extends the Frobenius norm to all color channels when computing the weights for NLM. Lastly, comparison of k-means clusters is used as a selective condition for non-local means. Using high-performance computing, parameters for each method are varied to achieve optimal denoising as quantified through the peak signal-to-noise (PSNR) and structural similarity index measure (SSIM) metrics. The combined variational-NLM approach outperforms conventional techniques applied to individual color channels; however, finding optimal parameters is more time-intensive. The extended Frobenius norm method improves perceptual denoising and edge retention when compared to standard NLM.

37
Name: Wade, Lynn
Major: Biochemistry
Faculty Advisor Name, Affiliation: Seung-Joon Ahn, Biochemistry, Molecular Biology, Entomology and Plant Pathology
Project Category: Biological Sciences and Engineering
Co-Author(s): Dr. John Cartwright, Dr. Gerald Baker
REU/Research Program: College of Agriculture and Life Sciences URSP

Leaf skeletonization: Life cycles, morphology and distribution of the voracious sawflies found in MSU campus

Sawflies are a member of primitive wasps whose immature larval stage feeds on many trees and shrubs in the landscape. They feed on the green part of the leaves, leaving only leaf veins behind, a feeding habit called “leaf skeletonization”. It causes defoliation and reduces plant health, eventually resulting in mortality if seriously repeated. Mississippi State University is home to a variety of plants susceptible to sawfly feeding. We identified the hibiscus sawfly (*Atomacera decepta*) in the Hibiscus and rose mallows and the oak slug sawfly (*Caliroa* sp.) in the oak trees in the MSU campus. Little is known about these defoliators so, through this research project, the sawflies are carefully examined to gain more understanding about their life cycles, distributions, and digestive physiology. Here we present (1) their life cycles based on the observations throughout a whole year, (2) their morphological characteristics examined under scanning electron microscope, and (3) their distributions in different host plants in the main campus of Mississippi State University using a GIS map. Currently, we are conducting gut transcriptome analyses using RNA sequencing technology in order to understand their digestive biochemistry. This study will pave a ground for further investigations on the management strategies against the potential defoliators in the ornamental plants.

79
Name: Wallinger, Jayna
Major: Chemistry
Home Institution (Other than MSU): University of Missouri- Columbia
Faculty Advisor Name, Affiliation: Amanda Patrick, Chemistry
Project Category: Physical Sciences and Engineering
Co-Author(s): Taofiq Abdulraheem
REU/Research Program: INFEWS

Analysis of the Gas-Phase Dissociation of Fluorinated Ionic Liquids

Per-/poly-fluorinated compounds are those that contain carbon chains, often with other functional groups attached, that have many carbon-fluorine bonds. The strength and inertness of the C–F bond makes them useful in polymers, surfactants, lubricants, fire retardants, and insecticides. Due to this wide range of applications, poly-fluorinated compounds are very prevalent in many industries. Their strong C–F bonds are a double-edged sword, however, also making them very persistent and earning them the moniker "forever chemicals." Per-/poly-fluorinated compounds are persistent in the environment and can infiltrate the human body through water and food ingestion, inhalation, or skin transfer. Thus, the detection and characterization of these species is important for both environmental and health reasons. Tandem mass spectrometry is a commonly used analytical technique that allows compounds to be identified based on their fragmentation patterns. To make sense of such fragments of unknowns, it is necessary to understand the dissociation pathways of species of known structure. Here, we use tandem mass spectrometry to gain an understanding of how ionic liquid cations and anions based on per-/poly-fluorinated building blocks behave under such analyses. Two ionic liquids, 1-Butyl-1-(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)imidazolium hexafluorophosphate (BTIHF) and tetrabutylammonium nonafluorobutanesulfonate (TBNFS), were obtained from Santa Cruz Biotechnology and prepared as electrospray-compatible solutions (20 µM in 10 mL HPLC grade methanol). MS^2 and MS^3 analyses were performed on a Thermo LTQ Velos ion trap mass spectrometer. Neutral losses were assigned, and dissociation pathways were proposed. In addition to these gas-phase experiments, thermogravimetric analysis (using a TA Instruments Q50 TGA instrument) to understand the bulk thermal stability and computational chemistry to explore the thermodynamics of the dissociation pathways may be performed in the near future.

87
Name: Walters, Burgundy
Major: Biochemistry
Faculty Advisor Name, Affiliation: Sam Ward, Biochemistry, Molecular Biology, Entomology and Plant Pathology
Project Category: Social Sciences
Co-Author(s): Peers and Faculty in the Arkansas Summer Research Institute 2022
REU/Research Program: Arkansas Summer Research Institute 2022

Statistical Analyses of Hospital Population and CDC Stewardship in Relation to Antibiotic Resistance

Antibiotic resistance is a growing concern in the medical field. As of 2019, nearly 3 million antibiotic resistant infections occur each year with 35,000 cases being fatal. Particularly as the Corona Virus pandemic continues, precautions and guidelines are being created and implemented to minimize antibiotic resistance. In 2014 the CDC devised a stewardship program comprised of 7 core elements to be released on all hospitals in the United States. The program is designed to control the distribution and use of antibiotics to decrease the number of antibiotic resistant infections and prevent further spread. Prescription rates (the number of prescribed antibiotics from a hospital) are the most measurable variable that is affected by the program. By adhering to regulations about tracking, reporting, education, and expertise, changes in prescription rate can be indicative of program efficiency. In this project, participants in the Arkansas Summer Research Institute chose a provided data set to analyze in the way best fit to learn new information. The data set chosen for this project was constructed from CDC reports to determine the presence and degree of relationship between the number of hospitals in a state and the prescription rates through statistical testing and interpretation. Understanding how hospital population and prescription rates are correlated provides support for the stewardship program's proficiency and results can be used to guide updates to the program.

88
Name: Welch, Destiny
Major: Sociology
Faculty Advisor Name, Affiliation: Margaret Ralston, Sociology
Project Category: Social Sciences
REU/Research Program: ORED Undergraduate Research Program

Later Life Depression Among Older Women and its Relationship to Early-on Domestic Violence by Social Class

This study aims to determine whether or not events of domestic violence are related to later life depression among older women. Domestic Violence is violent and/or aggressive behavior within an individual's home, typically involving the abuse of an intimate partner or spouse. Our goal of this study is to compare how events of domestic violence relate to later life depression among older adult women from different social classes. Although many variables (education, occupation, income, wealth) are used to measure social class, this study focuses more on women's income brackets. We will use data from The National Longitudinal Study of Adolescent to Adult Health Parent Study. The Add Health is a longitudinal survey with a nationally representative sample of adults and their parents age 50 to 80 (N=2,244). We will use descriptive statistics and OLS regression to test our hypotheses. This topic is of importance because the long-term effects of domestic violent experiences are still being researched and discovered. The United States population is also aging and this leads to the need for further research involving their mental, physical, and emotional wellbeing in this society. As Sociologists, we will be adding to this conversation by comparing and navigating these topics deeper within the realms of social class. We expect that experiencing domestic violence will increase depression among older women but that this will be most likely the case for individuals from a lower social class.

89
Name: Welch, Jaycie
Major: Psychology
Faculty Advisor Name, Affiliation: Hossein Karimi, Psychology
Project Category: Social Sciences

Human Language Processing

In the Cognition of Language Lab, we investigate the cognitive processes that contribute to human language processing, including memory operations such as encoding, storage and retrieval. Also, we study the effect of cognitive decline on human memory and language processing systems. Uses of behavioral and neuroscience techniques such as EEG are used to investigate questions. The purpose of this is to perform an experiment to see which of pre- or post- modifiers are more memorable to the target noun, using sentences such as, “the cruel and merciless king criticized the prince” (pre-modifier) or “the king who was cruel and merciless criticized the prince” (post-modifier) as the experimental sentences. Sixty fillers were interspersed with the experimental items in a pseudorandomized order. That is, all the sentences (filler and experimental sentences) were randomized once and all lists were presented in that same order for all participants. Participants received the experimental list in the form of a booklet and were asked to write a continuation for each sentence. The participants were encouraged to produce their continuations “quickly” and “with the first thing that comes to mind.” In the experiment, participants used more pronouns (he), as opposed to full descriptions (the king) to refer to post-modified noun phrases than to unmodified competitors, suggesting that post-modified noun phrases are more accessible in memory. These results are significant because it gives the research an idea on how associative memory works with pronouns in noun phrases.

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Name: Zolboot, Arigaa
Major: Chemical Engineering
Faculty Advisor Name, Affiliation: Heejin Cho, Institute for Clean Energy and Technology (ICET); Gentry N. Berry, Institute for Clean Energy and Technology (ICET)
Project Category: Physical Sciences and Engineering

Comparison of Segmentation Techniques to Analyze Fibrous Media

Nuclear and various waste management facilities use fibrous High Efficiency Particulate Air (HEPA) filters to capture any contaminated airborne particles that may be present in the air before releasing them to atmosphere or other occupied spaces. HEPA filters by definition are 99.97% efficient for 0.3µm particles and have a pressure drop depending on several media parameters, such as media thickness, fiber size, and fiber packing density. Thus, the accuracy of determining a mean fiber diameter is essential for estimating and evaluating the initial pressure drop across a clean filter. Various manual and analytical methods have been previously used to determine the fiber diameter such as calculating the diameter based upon measured experimental quantities or using an image generated from a Scanning Electron Microscope (SEM). This work focuses on SEM imaging of a fibrous media to analyze the fiber diameter using various segmentation techniques available with DiameterJ, Weka, and manual methods using ImageJ. The original gray scaled SEM image is compared with the binary segmented images and the accuracy of the segmentation techniques is determine by the overlap of original and segmented images. The aim of this study is to suggest the most time-efficient and most accurate segmentation technique to determine the fiber diameter.

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OFFICE OF PRESTIGIOUS EXTERNAL SCHOLARSHIPS

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For appointments regarding general scholarship opportunities or preliminary editing of essays, please contact Maria Schrupp, Graduate Assistant to the OPES.

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