MSU™

undergraduate research

SHOWCASE

SUMMER 2023

august 2nd
griffis hall

MISSISSIPPI STATE UNIVERSITY™
UNDERGRADUATE RESEARCH
AND CREATIVE DISCOVERY

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UNDERGRADUATE RESEARCH
AND CREATIVE DISCOVERY

WELCOME TO THE UNDERGRADUATE RESEARCH SHOWCASE!

The Shackouls Honors College is pleased to host the Summer 2023 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

UNDERGRADUATE RESESARCH SHOWCASE SCHEDULE

Summer 2023

August 2

Check in		
TIME	**EVENT**	**LOCATION**
1:00 p.m. - 1:50 p.m.	Check In for Presenters	Griffis Hall Lobby
1:30 p.m. – 2:00 p.m.	Check in for Evaluators	
Physical Sciences & Engineering (Projects 1-45)		
TIME	**EVENT**	**LOCATION**
1:30 p.m.- 2:00 p.m.	Student Viewing of Other Posters	Griffis Hall 1st-3rd Floors
2:00 p.m. - 4:00 p.m.	Poster Session	
Biological Sciences & Engineering (Projects 46-89)		
TIME	**EVENT**	**LOCATION**
1:30 p.m. - 2:00 p.m.	Student Viewing of Other Posters	Nunnelee Hall 1st-3rd Floors
2:00 p.m. - 4:00 p.m.	Poster Session	
Social Sciences (Projects 90-101)		
TIME	**EVENT**	**LOCATION**
1:30 p.m.- 2:00 p.m.	Student Viewing of Other Posters	Griffis Hall 1st-3rd Floors
2:00 p.m. - 4:00 p.m.	Poster Session	
Arts & Humanities (Oral Presentations) & Posters (102-106)		
TIME	**EVENT**	**LOCATION**
2:05 Humanities & Arts Poster session (105-6) will begin upon completion of oral presentations (approximately 3pm).	**Rowan Feasel (102)** *Frankenstein* Through Friedan: Monstrous Fathers and Unhappy Housewives **Anne Louise Phillips (103)** Star Wars as a Modern Mythology **Erin Quinn (104)** Beyond "His Native Town": Travel and Alienation in Mary Shelley's *Frankenstein*	Griffis Rm 307

Join us for refreshments on the first floors of Griffis and Nunnelee Halls

CONTENTS

Student Abstracts

46

Name: Amaya, Alejandra
Major: Biomedical Engineering - Bachelor of Science
Faculty Advisor: LaShan Hendrix, Ag & Bio Engineering
Co-Author(s): Jessie Moon
Funding: Mississippi INBRE, funded by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under grant number P20GM103476.
Project Category: Biological Sciences & Engineering

Examining the Role of Mechanotransduction in Vascular Smooth Muscle Cell Calcification

One of the leading causes of death among patients with kidney disease or diabetes would be cardiovascular complications, such as vascular calcification. Vascular calcification (VC) is defined as an active process where vascular smooth muscle cells (VSMCs) will phenotypically transition to osteoblast-like cells, depositing hydroxyapatite crystals within the arterial tissue. This could lead to diseases such as atherosclerosis, restenosis, and hypertension. The triggers that lead to VSMCs transforming into osteoblast-like cells are unknown. Studies have shown that osteogenic markers such as runt-related transcription factor 2 (RUNX2) are directly linked to the canonical wingless/integrated (WNT) signaling pathway; in this pathway, bone formation and osteoblast differentiation occur. Under stiff matrix conditions, it is thought that proteins synergize with the WNT cascade thus further inducing osteogenesis through RUNX2 in arterial tissues, leading to an increase in calcification. Our hypothesis is that cyclic strain will cause calcification and the phenotypic switch of VSMCs to osteoblast-like cells. Human aorta smooth muscle cells (HASMC) were used and cultured in media that induces calcification. Once fully confluent in T75 flasks, various antibodies were used to test against VSMC markers, WNT pathway, bone, and ROS. Some of the testing done were a 24-hour stretch and calcification was detected qualitatively and quantitatively. Preliminary results show that there was an increase of calcium content in cells that were stretched and there were changes in the smooth muscle cell markers.

105
Name: Andrews, Hallie
Major: Art - Bachelor of Fine Arts
Faculty Advisor: Caroline Hatfield, Art
Co-Author(s): Liza Ambriz, Abi Parish
Funding: National Endowment for the Arts
Project Category: Humanities & Arts

"Welcoming Wiggles": Uniting and Brightening the Community Together Through Public Art

Public art is a great way to convey the style and values of a community, though funding and completing public works is a major undertaking for artists, officials, and community members alike. When the Fred Carl Jr. Small Town Center and the Starkville Area Arts Council announced a request for public art proposals, MSU's Advanced Sculpture class saw an opportunity to use our skills and creativity to address the plain exterior of Starkville's J.L. King Community Center, which has served the public for years with after school and adult learning programs. As part of our coursework, we collaborated on a design inspired by bright colors, movement, and nature that embodies the spirit of the center. Once awarded the project, we purchased the necessary supplies to fabricate freestanding metal sculptures and a dimensional wall mural. We then learned a combination of digital fabrication, welding, and painting techniques to create our installation, "Welcoming Wiggles". With funding from the National Endowment for the Arts and support from our instructor and the J.L. King center, we were able to gain valuable experience creating public art while celebrating the vibrancy and joy of the families that create, play, and learn at the J.L. King Center.

01
Name: Assaye, Amanda
Major: Chemistry - Bachelor of Arts
University: Agnes Scott College
Faculty Advisor: Nicholas Fitzkee, Chemistry
Co-Author(s): Chathuri S. Kariyawasam, Tanveer Shaikh
Funding: NSF REU: 2023 Summer REU: Food, Energy, and Water Security
Project Category: Physical Sciences & Engineering

Characterization of Different Nanoparticles Coated by Blood Serum Proteins

Within the biomedical field, nanoparticles are a promising tool for drug delivery due to their ability to combine multiple functions into a single package (e.g., tumor targeting, payload delivery, thermal response, etc.). Gold nanoparticles (AuNPs) can be extremely convenient for these purposes since they are easy to synthesize, have low toxicity, and are readily modified. Polystyrene nanoparticles (PSNPs) have also been explored for applications in biosensing. However, when either AuNPs or PSNPs are exposed to blood serum, they are instantly surrounded by blood proteins, which form a "protein corona" on the nanoparticle surface. This is not desirable because the corona influences the nanoparticles' fate unpredictably. Specifically, the protein corona can disrupt the intended cell targeting, trigger an unwanted immune response, or increase the pharmacokinetic clearance rate. By understanding how proteins interact with serum-coated nanoparticles, we can analyze the mechanisms that influence the nanoparticles' predestined journey in biological systems. Here, we compare the functional differences between coronas on PSNPs and AuNPs. Using the simple GB3 model protein as a probe, and studying the thermodynamics of protein-nanoparticle interactions, we have examined the energetics of binding to these different protein coronas. Through this work, we hope to understand how the corona on PSNPs differs from the corona on AuNPs.

02
Name: Atilano, Lexi
Major: Chemistry - Bachelor of Arts
University: University of North Georgia
Faculty Advisor: Virginia Montiel Palma, Chemistry
Funding: NSF REU: INFEWS
Project Category: Physical Sciences & Engineering

Exploring the Catalytic Activity of NU-1000 Based Catalysts with Ni and Co Organometallic Linkers

In previous work by our lab, PSiiPr and PSi2iPr ligands have been bonded to several metals including Ni, Ir, and Rh. Some of those metal complexes were grafted onto NU-1000, a metal-organic framework (MOF) material, to act as a catalyst for silicon and boron functionalization of organic substrates, popular reactions used in many industries. Recently, a Ni complex derived from the PSiiPr ligand was synthesized and proved to be active for the hydroboration of aldehydes and ketones and in the hydrosilylation of alkenes. The complex is thought to retain its catalytic activity once grafted onto the NU-1000 MOF and comparisons can be drawn between the homogeneous and heterogeneous systems, highlighting the advantages of MOF grafting. Our interest to develop more economical catalysts analogs of the group 9 precious metals Ir and Rh has taken us to develop Co complexes which are much more economical in price. However, the PSi2iPr ligand has not been successfully coordinated to cobalt due to its challenging chemistry, its tendency to adopt different oxidation states and geometries than other metals in the same group. A new reaction pathway was used to synthesize an alkyl-Co(PSi2iPr) complex. Post-synthetic modification of the NU-1000 MOF with the aforementioned Co complex leads to a new material characterized by the usual techniques including PXRD, ICP-MS, and BET. The ability of the new Ni and Co materials to catalyze hydroboration and dehydrogenative silylation is herein presented.

03
Name: Bauer, Jack
Major: Mechanical Engineering - Bachelor of Science
Faculty Advisor: Wenmeng Tian, Industrial and Systems Engineering
Funding: NSF REU: CMMI-2046515
Project Category: Physical Sciences & Engineering

Internal Structure Characterization of Metal Fused Filament Fabrication Parts using Densimeter and X-Ray Computed Tomography

Metal Fused Filament Fabrication (FFF) is an additive manufacturing process in which metal powder in a polymer binding is heated and layered to form an object. The fabricated part must go through a debinding process in order to remove the polymer and a sintering process in order to densify the part, providing the final part. Due to the multistage nature of metal FFF, the fabricated parts demonstrate unique internal structural variabilities which are quite different from metal parts created through more common manufacturing processes. The part's internal structure is determined by various process parameters, such as the infill pattern of the printer and any impurities that appeared in the part during debinding and sintering. Therefore, there is an urgent need in characterizing the internal structure of the metal FFF parts for quality control purpose. Copper cubes have been manufactured using metal FFF for their structural characterization. The copper pieces density has been tested and shown to be less dense than elemental copper by an average of 45 percent. Furthermore, using an X-ray CT machine, the internal porosity of the copper cubes can be measured showing the porosity distribution of the part. The findings of these tests can quantify the densest part metal FFF could produce as well as the associated process parameters.

90

Name: Baymon, Tchuknequa
Major: Biological Sciences - Bachelor of Science
University: Delta State University
Faculty Advisor: Andrea Kunze, Counselor Education & Psychology, Delta State U
Co-Author(s): Aaliyah Johnson, Swayze Woods
Project Category: Social Sciences

Measuring Happiness: The Influence Nature has on an Individual's Mental Well-Being Based on Demographics

For centuries, mankind has benefited from nature in overall wellness. Regarding mental and physical wellness, nature has a broad spectrum of environments that allows for such benefits. It can span from positive green spaces like hiking trails, forests, beaches, oceans, or parks. Spending time outdoors is critical in enabling individuals to cope with stressors like depression, irritation, stress, and anxiety. In some instances, medical professionals have recommended fresh air combined with exercise as a holistic solution to feel better overall. For example, research into ecotherapy suggests that nature has been found to help with mental health problems such as depression and anxiety. Our connection to nature is responsible for nature's positive impact on an individual. This is called “connectedness,” which refers to how we relate to nature and our experiences in nature. This connection can be developed through outdoor activities such as biking, swimming, hiking, gardening, and bird-watching. Although we reap tremendous benefits from nature, it leads us to question the psychological aspect of spending time in nature and what factors contribute. In this study, we introduced the research question, “What emotions can occur when spending time in nature?”. We hypothesize that the most prominent emotion would be happiness. In order to stratify the data, we categorized 37 participants ranging from the ages 18 and older using the amount of time spent outside and two distinct demographic differences, which were gender and geographic location. With the creation of a survey, we measured negative and positive emotions using a Likert scale. Additionally, we asked the participants questions that would give insight into their connectedness to nature. Our findings indicate that spending more time in nature relates to higher levels of happiness and other positive emotions. Additionally, the majority of the participants have a solid connection to nature, which stipulates its influence.

47
Name: Bedics, Carson
Major: Biosystems Engineering - Bachelor of Science
University: Auburn University
Faculty Advisor: Yunsang Kim, Sustainable Bioproducts
Co-Author(s): Edward Entsminger
Funding: Department of Sustainable Bioproducts REEU
Project Category: Biological Sciences & Engineering

The Effect of an Essential Oil-Based Wood Preservative on Viscosity and Shear Strength of Wood Adhesive

Wood products typically have shorter lifespans than conventional, energy-intensive construction materials primarily due to degradation by biological agents such as fungi and termites. Furthermore, chemical preservatives used to enhance the durability of wood products, especially in outdoor applications, pose risks to human health and the environment. Therefore, there is a need to develop natural alternatives for wood preservation with reduced toxicity and environmental impact. In this study, natural biocide *trans*-cinnamaldehyde (*t*CN), was molecularly encapsulated within the cavity of a starch derivative, beta-cyclodextrin (βCD), using an ultrasonication method to create an inclusion complex serving as a natural wood preservative. The formation of the βCD-*t*CN inclusion complex was confirmed using attenuated total reflection-Fourier transform infrared spectroscopy, and its inclusion yield was estimated to be 140% using UV-visible spectrophotometry. The inclusion complex was added to polymeric methylene diphenyl diisocyanate (pMDI) resin at concentrations of 3%, 5%, and 7.5%, leading to an increase in the viscosity of pMDI by 11%, 20%, and 23% respectively. To assess the inclusion complex's influence as an additive on the adhesion performance of a wood composite, shear strength properties of the pMDI adhesive with the βCD-*tCN* additive were tested using Southern yellow pine 3-ply plywood specimens, following the ASTM D906-20 standard. The average shear strength of panels made with pure pMDI was 2.15 N/mm², while samples ranged between 1.39 N/mm² and 1.89 N/mm² for pMDI with additive loadings of 3% to 7.5%. These values exceeded the minimum requirement of 1.0 N/mm² for characteristic shear strength for cross-layer bond lines, according to the European standard EN 16351. The synthesized βCD-*tCN* preservative shows promise as an environmentally friendly alternative to toxic wood chemical preservatives.

04
Name: Berry, Megan
Major: Mechanical Engineering - Bachelor of Science
Faculty Advisor: Jason Street, FWRC-Sustainable Bioproducts
Co-Author(s): Yunsang Kim
Funding: USDA NIFA REEU Program
Project Category: Physical Sciences & Engineering

The Impact of Dried Distillers Grain with Solubles (DDGS) and Microcrystalline Cellulose (MCC) on the performance of Southern Yellow Pine Particle Board.

This study enabled up to investigate whether the utilization of dried distillers grains with solubles (DDGS), a more cost-effective feedstock alternative, and microcrystalline cellulose (MCC), a filler additive, could result in enhanced performance on the density profile and internal bond strength characteristics of southern yellow pine (SP) particle board. Six-inch square boards were produced with DDGS and MCC contents varying between 0, 1, 2, 5, and 10 percent respectively. Both SP and DDGS particles were dried beforehand and brought up to roughly 6% moisture before mixing. The SYP, DDGS, and MCC were mixed for 5 minutes before the adhesive (PMDI) was sprayed into the mixture. This blend of materials was allowed to mix for 10 minutes. Three boards were produced per batch of composite, each consisting of roughly 221g of product. Each board was pressed on a Carver hydraulic press at a temperature of about 415 degrees Fahrenheit at 328 psi. The boards were labeled and later cut into 2 inch by 2 inch samples and tested for IB strength. Statistical analysis of the internal bond data revealed that neither the DDGS nor the MCC caused a statistically significant difference in performance between treatment methods. Overall DDGS and MCC were found to have no significant impact on the performance of southern yellow pine particle board internal bond strength. This is a beneficial result for DDGS. DDGS is a cheaper alternative to wood particles, and the use of it in substitution of wood would drastically decrease the cost of particle board production. Future testing involving a bending strength study will be carried out to determine if MCC could be used to produce stiffer and stronger particle boards with varying concentrations of DDGS and SP.

91
Name: Bobo, Nicholas
Major: Psychology - Bachelor of Science
University: Delta State University
Faculty Advisor: Andrea Kunze, Psychology, Delta State University
Project Category: Social Sciences

Understanding Nicotine Usage In Undergraduate Students

As an undergraduate student myself, I have spent ample time around my peers in multiple settings. One constant I noticed is the use of nicotine products no matter the setting. Going further into this I wanted to better understand the connection between this usage and students school life. Two of my main focuses were on the reasoning behind the use of nicotine products, as well as the effects of these products. In future research I would like to look at other links such as habits and healthy alternatives to help those that want to quit addictive products such as nicotine.

48
Name: Boland, Rosemary
Major: Kinesiology - Bachelor of Science
Faculty Advisor: Harish Chander, Kinesiology
Co-Author(s): Hunter Derby, Nathan Conner, Jacob Hull, Sally Hatten, Timothy Stewart
Funding: NIOSH/CDC
Project Category: Biological Sciences & Engineering

Influence of real-world and virtual reality slip-trip training on gait and balance confidence

Perturbation-based balance training (PBBT) have been successful to improve balance, gait and minimize slips, trips, and falls. However, the physical hazards and the financial cost of PBBT equipment and access makes it cumbersome for universal availability. More recently, virtual reality (VR) in different scenarios have been used as an innovative tool for balance and gait training. The purpose of the study was to assess if a novel customized VR fall prevention training tool, using virtual slip and trip hazards was successful to improve gait and balance confidence, compared to real-world slip and trip hazard training. A total of 15 healthy young adults (8 females, 7 males, age 23 ± 3.31) completed two training conditions, real gait training and virtual gait training, which included real and virtual slip and trip hazards. All participants completed pre-training and post-training assessments that included three different timed-up-and-go (TUG) (traditional, cognitive, and manual) as well as a balance confidence survey (BCS). TUG times and BCS scores were analyzed using a one-way repeated measures ANOVA. Significant main effects were observed for the TUG cognitive ($p=0.022$) and the TUG manual ($p=0.041$) variations. Follow up comparisons revealed significantly faster times after the VR training compared to pre-training. Findings suggest that the VR training tool was successful in improving gait significantly and while not statistically significant, balance confidence also improved, thereby providing evidence and support for the novel VR training tool with slip and trip perturbations to be used for balance and gait improvement. Findings also demonstrated that using virtual environments with slip and trip hazards in a highly realistic environment elicited significant acute improvements in the postural control and gait systems and offers a promising method for improving gait and postural control, with the subsequent benefit of mitigation of the injury risk and cost of falls.

49
Name: Brannon, Eric
Major: Biological Sciences - Bachelor of Science
University: Alabama Agricultural and Mechanical University
Faculty Advisor: Adriana Donizetti Carvalho Costa, FWRC-Sustainable Bioproducts
Funding: USDA REEU
Project Category: Biological Sciences & Engineering

Wood Identification by Chemical Reactivity Using Chrome Azurol-S

According to US Customs and Border Protection, illegal logging is the most lucrative form of transnational natural resource crime. This revelation highlights the urgent need for effective measures to combat this issue. A promising solution lies in utilizing the Mississippi State University David A. Kribs Wood Collection to develop innovative wood identification methods to fight illegal logging. Wood identification traditionally relies on observing its anatomical features, but other techniques can be additionally employed for this purpose. One of these techniques is identifying wood species containing high levels of aluminum that react with chrome azurol-S. To expand on prior studies, we investigated chrome azurol-S reactive species using a recent acquisition of 2,073 specimens obtained by the David A. Kribs Wood Collection from Michigan Tech University. This new addition includes 1,695 species and 770 genera, with 236 species listed across all categories of the International Union for Conservation of Nature's (IUCN) red list and 49 species listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The application of a chrome azurol-S solution to the specimens´ surface resulted in 23 species exhibiting a reaction. Of particular interest were two species, Axinandra zeylanica, and Qualea rosea, both categorized as vulnerable according to the IUCN red list. In addition, four species were found, for the first time, to respond to chrome Azurol-S, including Axinandra zeylanica, Croton killipianus, Baccharis braunii, and Octea sp. These findings have significant implications for the preservation of vulnerable species identified by the IUCN. By utilizing Chrome Azurol-S, these species can be easily and accurately identified, contributing to their protection against illegal logging. The results of this investigation highlight the importance of ongoing research and the critical role innovative approaches can play in preserving our natural heritage.

05

Name: Breland, Leanna
Major: Mathematics - Bachelor of Science
Faculty Advisor: Hui Xue, School of Mathematical and Statistical Sciences, Clemson University
Co-Author(s): Laura O'Brien, Kevin Le, Jingchen Ni
Funding: NSF REU: Clemson Number Theory REU
Project Category: Physical Sciences & Engineering

Interlacing of Zeros of Period Polynomials

Period polynomials of modular forms are the generating functions for special values of L-functions, which have helped generate significant progress in areas such as the arithmetic of elliptic curves, the Birch and Swinnerton-Dyer conjecture, and the Bloch-Kato conjecture. Seokho Jin, Wenjun Ma, Ken Ono, and Kannan Soundararajan published a paper entitled "Riemann Hypothesis for Period Polynomials of Modular Forms" in which they proved that all the zeros of the degree k-2 period polynomial $r_f(z)$ for a newform $f \in S_k(\Gamma_0(N))$ lie on the circle $|z|=1/\sqrt{N}$. They also proved that the zeros become equidistributed for large k or N. We study the sample zeros of $r_f(z)$ given by Jin et al. to show that if $k'>k\geq 78$ or $N\geq 196476$, the zeros of $r_f(z)$ not only are equally distributed but also interlace with the zeros of the period polynomial associated with $f' \in S_{k'}(\Gamma_0(N))$. When either k or N is large enough, the upper bound of the distance between sample and actual zeros, $C(k,N)/2m\sqrt{N}$, can be arbitrarily small. Thus, the interlacing and Stieltjes interlacing between sample zeros ensure the (Stieltjes) interlacing of actual zeros of $r_f(z)$.

06
Name: Buccella, Sophia
Major: Chemistry - Bachelor of Arts
University: La Salle University
Faculty Advisor: Neeraj Rai, Dave C. Swalm School of Chemical Engineering
Co-Author(s): Woodrow N. Wilson, John Michael Lane
Funding: NSF REU: CCS
Project Category: Physical Sciences & Engineering

Large scale reactive molecular dynamics of methanol and water in Brønsted acid MFI with a Bayesian force field

The development of catalysts for the selective conversion of biomass to fuels and chemicals is necessary to meet our future energy needs in a sustainable manner. Zeolites, solid acid catalysts, are attractive catalytic materials for biomass conversion. Due to the complexity of the solvation environment near the zeolite active sites, computational modeling of these processes is a significant challenge and require quantum mechanical treatment to capture chemical reactions. Due to prohibitive computational cost, these approaches are limited to very small models that do not adequately represent experimental systems. Machine-learned force fields (ML-FFs) trained on ab initio molecular dynamics (AIMD) trajectories enable large scale reactive molecular dynamics while being computationally tractable. Here, we develop ML-FFs based on sparse Gaussian process regression for the reactive diffusion of methanol and water in Brønsted acid MFI zeolites at varying silica-to-alumina ratios. The solvent dynamics and local solvation structure is examined as a function of the location of the Brønsted acid sites in the zeolite. Preliminary results show that these sparse Gaussian process regression-based force fields enable simulations at timescales 2,000 times larger than that of ab initio MD for systems that are twelve times as large. This study elucidates the complex solvation environment for Brønsted acid zeolites and illustrates the power of using ML-FFs for the liquid-phase heterogeneous catalysis.

50
Name: Butler, Elliott
Major: Biological Engineering - Bachelor of Science
Faculty Advisor: Mary Love Tagert, Agricultural and Biological Engineering
Co-Author(s): Zeb Green
Project Category: Biological Sciences & Engineering

Geospatial Inventory of Irrigation Infrastructure in Northeast Mississippi

The Blackland Prairie region of Mississippi receives an average annual precipitation of 131 cm with only 37% of that occurring during the growing season. The number of irrigation systems and surface water storage in northeast Mississppi has increased over recent years to supplement rainfall and reduce risk. An on-farm water storage (OFWS) system captures and stores precipitation runoff while simultaneously capturing nutrients to mitigate stream impairment. Runoff during the off-season will be stored in the OFWS for irrigation during the growing season. In northeast Mississippi, OFWS systems have typically been privately funded due to minimal federal cost assistance related to irrigation, so the number of storage systems and irrigated area are likely underestimated. An inventory of OFWS systems, sprinkler irrigation systems, and irrigated area was conducted for 22 counties in northeast Mississippi to assess the extent of irrigation in this region. For the inventory, 2020 imagery from the USDA National Agriculture Imagery Program (NAIP) was used in conjunction with Google Earth, with spatial resolutions of 60 cm or higher and 15 cm or higher, respectively. The NAIP imagery has four bands that may be viewed in natural color or infrared and was input into Esri's ArcMap software where a 1 km2 grid was overlaid onto the image to analyze each section. When identified on the NAIP imagery, OFWS systems were digitized into an polygon shapefile and a single point was used to mark the center pivots. Another polygon shapefile outlined the irrigated area. To date, 1,349 hectares of surface water storage have been identified, along with 17,604 hectares of irrigated area. Ground-truthing of 50% or more of all systems identified is ongoing, and future work includes a comparison of collected data to the 2018 Irrigation and Water Management Survey conducted by the USDA's National Agricultural Statistics Service.

07
Name: Chetney, Jake
Major: Physics - Bachelor of Science
University: Rochester Institute of Technology
Faculty Advisor: Gombojav Ariunbold, Physics & Astronomy
Co-Author(s): Bryan Semon
Funding: NSF REU: Computational Methods with applications in Materials Science
Project Category: Physical Sciences & Engineering

Coherent Anti-Stokes Raman Scattering Signal Enhancement

Coherent Anti-Stokes Raman Spectroscopy (CARS) utilizes Raman scattering, a third order polarization effect, to describe the molecular vibrational modes of a material. The technique is used in many applications, including the detection of bacterial spores, implementation of Coherent Raman microscopy, gas-phase thermometry, and more due to its ability to produce a nearly instantaneous spectral fingerprint of a sample. A major hindrance to obtaining a pure CARS spectrum is non-resonant noise caused by other nonlinear optical effects. The primary source of CARS non-resonant noise is four-wave mixing (FWM), another third order polarization effect that produces light with different combinations of the incident light frequencies when multiple frequencies of light are present. Nonetheless, various experimental techniques can help minimize this obstacle. Most experimental implementations of CARS use a series of ultrashort laser pulses: the pump and Stokes pulses excite molecules to their molecular vibrational modes coherently and a third, delayed, probe pulse is then scattered from the coherently vibrating molecules. The delay is crucial because the FWM signal has been significantly reduced by this time. However, the coherent vibrations of the molecules are also dissipating, meaning the delay cannot be too long. There is an optimized delay, known as the threshold delay, where the CARS signal is at a maximum and the FWM signal has been significantly reduced. For my project, I investigate the relationship between the threshold delay, derived from the theoretical CARS polarization closed form expression, and probe bandwidth and other experimental parameters, and how they constitute a closed form relationship. These results will help experimentalists accurately estimate the threshold delay and optimize the CARS spectrum signal within their experimental constraints.

51

Name: Conerly, Madeleine
Major: Biochemistry - Bachelor of Science
Faculty Advisor: Michael Garrett, Department of Cell and Molecular Biology, University of Mississippi Medical Center
Co-Author(s): Andrew Milner, Ashley Johnson, Lavanya Challagundla
Funding: This work was supported by the Mississippi INBRE (P20GM103476) and Molecular Center of Health and Disease COBRE (P20GM144041) funded by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health.
Project Category: Biological Sciences & Engineering

Mapping the Kidney Cell Types in iPSC-Derived Organoids Using snRNAseq

Chronic Kidney Disease (CKD) impacts nearly 14% of US adults and is linked to hypertension and reduced nephron (functional unit of the kidney) numbers. Our laboratory has established a novel inbred genetic model (HSRA rat) in order to study the impact of low nephron number both genetically and physiologically. Clearly, there is a genetic component in the model which predisposes offspring to exhibit unilateral renal agenesis about 50-75% of the time. The solitary kidney rats (HSRA-S) have been shown to develop hypertension and kidney injury compared to normal two-kidney controls (HSRA-C). Interestingly, embryos (n=120) extracted over different gestational days demonstrate an ~2 fold increase of solitary kidneys in the middle of the uterine horn compared to the uterine ends, $p<0.02$. The aim of this study is to determine and understand the genetic causes of this single kidney trait during kidney development. This model has inspired further research into using human pluripotent stem cells to cultivate “kidney organoids” - an in vitro kidney model developed from cells. We hypothesize that these organoids will serve as a testing ground for genes identified in the rat. However, first we have to validate that the stem cells did indeed differentiate into distinct clusters of kidney cell types. Over the course of eighteen days, the kidney organoids were grown and then frozen until nuclei could be isolated from them, along with fetal kidneys (E17.5). With quantity and viability assessed, both were then used for single nuclei RNA sequencing (snRNAseq) which unravels the RNA transcripts within different cell types for each sample. Sequencing is complete, and bioinformatic analysis using Seurat is in process to identify the differentiation outcome through visualizing cell types.

92
Name: Cooper, Fa'Darryl
Major: Accounting - Bachelor of Accountancy
University: Delta State University
Faculty Advisor: Andrea Kunze, Counselor Education & Psychology, Delta State University
Project Category: Social Sciences

Unlocking the Potential of Music in Education: The Effect of Music on Cognitive Behavior and Emotions in Education Studies

As we know music has been an integral part of human culture for centuries, and has the ability to evoke powerful emotions and memories. But did you know that music can also have a profound impact on cognitive function and emotional well-being? Research has shown that listening to music can enhance concentration, improve memory retention, and even elevate mood. In this study, we explore the fascinating connection between music and the human brain, and investigate how different types of music are perceived to affect our cognition and emotions in unique ways. This study will employ a survey design to investigate the connection between studying with music preferences and how participants perceive the effect on their cognition and emotions. The study will also look at the emotional advantages of music instruction, including its capacity to enhance good feelings and lessen bad ones like anxiety and sadness. The study will involve a diverse group of participants, ranging from children to adults. Ultimately, the findings of this study could have significant implications for education policy and practice, highlighting the importance of incorporating music instruction into school curricula and promoting its use as a therapeutic tool in clinical settings. The study will shed light on the processes through which music influences cognitive and emotional processes and on the possible advantages of including music instruction in the school curriculum. Overall, the goal of this research is to advance our knowledge of how music affects cognition and emotion in the context of education and to offer evidence-based suggestions to teachers and policymakers about the potential advantages of music education for students' social, emotional, and cognitive growth.

08
Name: Cooper, Rachel
Major: Chemistry - Bachelor of Arts
University: University of Michigan
Faculty Advisor: Mahesh Gangishetty, Chemistry
Co-Author(s): Anuraj Kshirsagar
Funding: NSF REU: INFEWS
Project Category: Physical Sciences & Engineering

Short Aromatic Diammonium Cation Based Sb3+ Doped Indium Halides for Light Emitting Diodes

Organic-inorganic hybrid metal halides have been well explored for various optoelectronic applications including light-emitting diodes (LEDs) and solar cells due to their exciting optoelectronic properties. Exploration of different organic A-site cations to synthesize exciting new materials with different electronic dimensionality has gained tremendous interest. However, such efforts are limited to the hybrid lead halide perovskites that have led to new materials with exciting structural and optoelectronic properties. Here, we present three different short aromatic diammonium halides for the four new indium halides, including a double perovskite, that upon Sb3+ doping show exciting optoelectronic properties suitable for LEDs. Halide salts of p-phenylene diamine, p-xylylenediamine, and m-xylylenediamine are employed as A-site cations to obtain single crystals of indium halides. The crystal structures of these new materials are obtained by single-crystal XRD. Interesting changes in optical properties upon Sb3+ doping, especially a new absorption feature near 330 nm that is assigned to the characteristic electronic transition 1A1g → 3T1u*, are observed. The photoexcitation at 330 nm shows bright orange and green emission with a photoluminescence quantum yield of more than 70 % and PL lifetime in microseconds. Owing to such exciting optical properties, these Sb3+ doped indium halides are explored in light emitting diodes.

09
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Funding: NSF REU: Computational Methods with Applications in Materials Science.
Project Category: Physical Sciences & Engineering

Molecular Photophysics of Molecules Used in OLED Devices and Light Harvesting Materials.

Organic light emitting diode (OLED) technology and devices have become increasingly popular due to their high efficiency, sustainability, and energy efficiency. They also reduce fuel consumption and greenhouse emissions, but the manufacturing process of these can be difficult and expensive. One way to reduce the cost is to use an earth-abundant element, such as iron, in the material. In the current study, iron complexes have been studied in order to better understand their photophysics. While current iron complexes are not available for use in OLED devices, their properties can be studied to gain a better understanding and the results can be used to design future materials. In this research, the molecular and electronic structure of iron complexes with respect to their light-emitting properties, the photoexcited states and transient intermediates, and the spectroscopy and relative energetics of these iron compounds were studied. The computed spectroscopic data can be compared to the experimental data. We can use this information to design improved molecules for use in OLED devices, while also predicting their properties. This can help reduce costs and create more accessible and environmentally friendly products while advancing knowledge within the study of species used in OLED devices.

10
Name: Crowsey, Sarah
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Faculty Advisor: Mary Mackey, Chemistry & the Physical Sciences, William Carey University
Funding: NSF REU: DMR-1950387
Project Category: Physical Sciences & Engineering

Investigating Biofilm Formation on Polymer Substrates Via Flow Cells

Biofilms are colonies of bacteria which form on surfaces and secrete a matrix composed of nucleic acids, proteins, lipids, and other molecules, granting them increased antibiotic resistance and greater adhesion to surfaces. Biofilms pose a serious medical problem by playing a role in antibiotic-resistant infections that stem from their growth on the surfaces of polymer-based medical devices including catheters, gastric mesh, and prosthetics. This research project used bacteriophages, highly specific viruses that target and destroy bacterial cells, to control and prevent biofilm formation on polymer surfaces by creating a surface layer of attached bacteriophages. Plasma was used to attach maleic anhydride (MA) to polypropylene (PP) to act as a binding agent between the protein head of the bacteriophages and the polymer surface. This process was optimized by varying time of exposure to plasma to find the ideal attachment conditions. The results from these trials were evaluated using attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy and it was found that 45 minutes of plasma exposure was optimal. After attachment of the MA, carbodiimide coupling chemistry was used to covalently bond the bacteriophages to the MA. Static condition plates were then used to optimize biofilm formation on polymer surfaces. After the static condition trials, flow cells designed specifically for holding these polymer samples were used to observe the effects of time of incubation and flow speed on biofilm formation and the anti-biofilm effects of the bacteriophage-coated surfaces. Biofilm formation was evaluated using crystal violet staining and subsequent measurement of absorbance using a UV-Vis spectrophotometer. The dynamic fluid trials using the flow cells showed improvement in biofilm quality after alterations to the flow circuit, and results indicate that future trials using E. coli instead of S. aureus may be helpful in optimizing experimental parameters.

52
Name: Culwell, Julius
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Funding: Northfork Equine Services
Project Category: Biological Sciences & Engineering

Pedigree tracing to determine origins of the Golden American Saddlebred Horse

With the inclusion of the Golden American Saddlebred Horse Association (GASHA) within the American Saddlebred Horse Association (ASHA), the emphasis for breeding specifically for coat color within the breed registry was minimized. Nevertheless, historical documentation through pedigree tracing can be valuable in understanding the origin of the breed and this can be of particular value to registries targeting a specific coat color as the study of coat colors is a new field of research within equine sciences. Thus, the objective of this study was to document the historical origins of the GASHA through pedigree tracing to determine the influence of the champagne and cream dilution genes. A random sample of 550 horses was obtained from the Official Directory of the GASHA. Using the All-Breed Data Base, sampled horses were entered and examined for pedigrees suitable for analysis of color inheritance, and of these, 507 were found to have extended pedigrees with documented coat colors that were utilized for this study. Results determined 43% of traced pedigrees carried the champagne gene, 36% carried the cream dilution gene, and 20% had pedigrees that were non-informative as these pedigrees went to unknown ancestors or were found to be incorrect as to ancestry. Another 1% was determined to be obligate carriers for the crème dilution gene as the pedigrees presented conflicts concerning color designation so that accurate conclusion of coat color phenotype associated with the crème dilution gene could not be verified. Of the 507, all traced back to 6 foundation mares and the majority of the breed traced back to 2 mares with one mare, Maud, being a champagne mutation and the other, Allens Queen, a cream mutation. In conclusion, through pedigree tracing the GASHA origins were documented giving an understanding as to the genetic contributions for today's GASHA golden coat color.

11
Name: Dejean, Lillian
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Funding: NIH
Project Category: Physical Sciences & Engineering

Component Selection and Requirements for an Open-Source High-Temperature 3D-Printer Capable of Printing Bio-Compatible Filaments

Materials such as ULTEM and PEEK are currently used in bone and dental implants. In recent years, the manufacturing of these products has begun to include 3D printing technology because of its ease of handling, small production runs, and the introduction of customization. One of the challenges of 3d printing with PEEK and ULTEM is that they require higher printing temperatures than more widely used polymers (e.g., ABS and PLA). There are very few commercially available 3D-printers that can print these filaments, and all are cost prohibitive. Open-source, high-temperature 3D-printers can address these concerns. This work focuses on the component selection and performance requirements needed to design and construct a high-temperature 3D-printer with extensive monitoring capabilities to analyze the printing process and integrity of structures. The development of this printer will allow for the benefits of materials such as PEEK and ULTEM to be more easily utilized.

93
Name: Driskill, Sean
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Funding: R-25
Project Category: Social Sciences

The modification benefits affect on age.

The modification benefit is a very useful tool that can help us with memorization. The only issue we are currently concerned with is whether or not this effect benefits older adults the same way. So, we created a series of tests to decide whether or not these people would be eligible for a memory test and then, assuming they were eligible, we examined how the modification benefit affected both older and younger people. The age ranged from 17-35 and from 60-85, and we used a self paced reading test that included a target word, a competitor, a semantically similar word, a phonologically similar word, and an unrelated word to try and see if the modifiers helped people identify the target correctly. The sentences we used consisted of 20 post-modified targets, 20 pre-modified targets, 20 unmodified targets, and 100 fillers. We found that older adults were significantly more accurate than younger adults, but the older adults also had a much slower reaction time. We found that the older adults had a more powerful modification benefit; therefore, our hypothesis was incorrect, but this study showed us that maybe it is the amount of time spent that helped the older adults so much.

12
Name: Elder, Zoe
Major: Biochemistry - Bachelor of Science
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Funding: MS INBRE, funded by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under grant number P20GM103476
Project Category: Physical Sciences & Engineering

Photochemical Key Steps in Cyclization Reactions: Synthesis of Isoindolone Piperidines As Kinase Inhibitors

Cancer cells are the result of disruption of tightly regulated metabolic pathways. This leads to uncontrolled proliferation of cells as seen in invasive tumors. Inhibition of certain metabolic enzymes thus might provide a tool to minimize the harmful effects of excessive cell growth. Two key phosphorylating enzymes, glycogen synthase kinase-3 (GSK3) and cyclin-dependent kinases (CDKs) are the target of researchers to interfere with cancer metabolism. Valmerins are isoindolone piperidines that have been shown to inhibit GSK3/CDK enzymes during cell proliferation. In this project, we are using the photodecarboxylative cyclization as a key step in the synthesis of GSK3/CDK inhibitors. The syntheses are initiated from affordable building blocks and culminate in the stereo-controlled synthesis of the target molecules. Variations in the chromophore lead to the formation of regioisomers, the control of which is important. Electron-donating and electron-withdrawing effects of the substituents might direct the cyclization to one side of the imide.

13
Name: Ellis, Daniel
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Funding: Department of Energy Office of Environmental Managment
Project Category: Physical Sciences & Engineering

Experimentation with Models of Particle Filter Loading

Clean air is a necessity for public safety and filtration systems are an essential element in ensuring air quality. Filtration is needed in fields such as nuclear energy to capture dangerous contaminants in the air from daily facility operations, as well as providing safety assurances in the event of a system failure. The interactions between aerosol particles and filters have been heavily studied in the macro and micro view, but there are important research gaps remaining, specifically focusing on the entire filter loading process. The life cycle of a filter may be divided into three loading regimes: 1) depth loading, 2) transition loading, and 3) surface loading. Many studies tend to focus on either the depth loading or surface loading process, with only a handful of models addressing the full spectrum of loading regimes. This study's purpose is to add to the body of knowledge regarding full loading models of fibrous filters by collecting experimental data throughout the entire filter loading cycle and applying it to selected models for analysis. The experiments were conducted using a small-scale test stand with high-efficiency filtration media, where the media's pressure drop was measured while simultaneously measuring the particle concentration and size distribution of the test aerosol used to challenge the filter. Results and conclusions are discussed, and future research is suggested.

102
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Project Category: Humanities & Arts

***Frankenstein* Through Friedan: Monstrous Fathers and Unhappy Housewives**

In the 1818 novel *Frankenstein*, Mary Shelley explores the impact of family and work on the ambitious titular character. Shelley acknowledges the importance of personal relationships since even the monster yearns for companionship, and she reveals the consequences of Victor Frankenstein's pursuit of scientific knowledge at the expense of his family. Many scholars have analyzed Shelley's novel as a warning against an obsessive devotion to a career, but an understanding of Betty Friedan's twentieth century argument in *The Feminine Mystique* allows modern readers to better assess Shelley's work. Friedan's novel describes the family as an institution that confined many women in the United States rather than a source of fulfillment. She shows that family structures can rob individuals of their identities and that interests outside the home can liberate people. While Frankenstein's demise certainly highlights the importance of family, the character of Elizabeth provides a different portrayal of domestic life even within a story that seems to promote prioritizing families over careers. Like many of the unhappy housewives in Friedan's novel, Elizabeth suffers because of her complete dedication to the household. My research ultimately examines Shelley's depiction of the family through Victor's and Elizabeth's contrary experiences, and I argue that Elizabeth, who loses her life because of her relationship, complicates a text which proclaims that individuals should value their families.

53
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Funding: NSF REU: Ole Miss Department of BioMolecular Sciences STEMs REU
Project Category: Biological Sciences & Engineering

Developing Zebrafish Assays for Autism Spectrum Disorder Behavior

Autism Spectrum Disorder (ASD) is a highly heritable neurodevelopmental disorder that can be induced through complex and unknown genetic-environmental interactions. In recent years not only has the number of diagnoses of ASD cases risen but also the connection to environmental factors, including air pollution. The main concern is the component, fine particulate matter (PM2.5), that is known to induce oxidative stress and disease. Association has been found between PM2.5 exposure and ASD, both of which disproportionately affect underprivileged groups. The effect PM2.5 exposure has on lung physiology has been well studied, but connections to ASD and other neurodevelopmental disorders have not. To bridge the gap in knowledge and reassess the severity of risk of PM2.5 exposure, we will use zebrafish to identify behavioral alterations associated with ASD. This project aims to develop and optimize the methods and assay vessels required to conduct these experiments across various exposure conditions. Optimizing the shoaling, social contact, locomotor response, light/dark preference, and mirror attack behavioral assays will allow for examination of how PM2.5 impacts anxiety, explorative behavior, aggression, and sociality to determine whether ASD-like behaviors occur. Literature review of the assays was conducted to identify optimal parameters to create custom plates. Currently, control fish behavior (n=50) is being compared to the results from previous studies using these tests. Future experiments will be able to analyze the behavioral results from exposure to PM2.5 from different sources and if certain compounds may be able to recover altered behavior.

14
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Funding: Shackouls Honors College Research Fellowship
Project Category: Physical Sciences & Engineering

Spatial Correlations Between Groundwater/Underground Storage Tank (UST) contamination at CERCLA sites, Income Distribution, and Racial Distribution in Mississippi

The Comprehensive Environmental Response, Compensation, and Liability Act, also known as CERCLA or Superfund, was created because of concern over hazardous wastes being leaked into the environment, and its purpose is to contain, clean, and manage sites of hazardous waste discharge or accidental leakage. The purpose of this research was to determine a spatial link between income, race, and contamination from these sites (per capita). If a relationship between these criteria can be proven, the results could be used to help disadvantaged communities prevent further contamination in the future and fight for safer storage and use of hazardous waste. This study was done in the program ArcGIS and used data from the U.S. Census Bureau and the U.S. Bureau of Labor Statistics on a county-level. Contamination events were taken from the Mississippi Department of Environmental Quality's GARD database. Each county's weekly income, racial percentage, total population, and contamination events at CERCLA sites were input manually into the program. The ArcGIS program, along with number of known contamination events and total population, was used for instances per capita. Geographically weighted regression, provided in ArcGIS, was used for the analysis of this data, and color-coded maps were created. Preliminary results show a slight correlation between income and contamination events per capita, and a greater correlation between race and contamination events per capita. As either weekly income in USD or the percentage of Caucasian citizens decrease, the number of known CERCLA site contamination events per capita increase. Though the link between income, race, and CERCLA site contamination is present, more research may be needed in the future to confirm this link as the correlation carries a degree of uncertainty.

54
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Funding: MSU REU
Project Category: Biological Sciences & Engineering

Catalytic Activity of Dehydrogenation and Hydrogenation Using a Novel Paddle-Wheel

Considerable attention is paid to formic acid (FA, HCO2H) as a hydrogen storage substance. Dehydrogenation of FA and hydrogenation of CO2 are significant reactions in this regard. In the last decade, several molecularly defined and nanostructured catalysts have been created and thoroughly investigated for both processes. This study includes recent developments in this field utilizing homogeneous catalysts from 2010 forward. The development of reversible H2 storage, including continuous H2 production from formic acid, is highlighted in addition to the development of catalysts for H2 generation. Recent developments in catalysts made of non-noble metals are given special attention. **Methods**: For the synthesis of complexes, all experiments were carried out under an inert atmosphere glove box using dry solvents, 1H, and 13C{1H}. NMR spectra were recorded on Bruker 300 spectrometers in either benzene-d6 or acetonitrile-d3 at ambient probe temperature (292 K). 1H and 13C NMR chemical shifts were determined by reference to the residual solvent resonances as internal references. The catalytic reactions were performed using standard soft techniques. 1H NMR and direct integration determined the products and conversion. The amount of Hydrogen generated was measured using an inverted water-filled burette. **Results**: Aluminate, Peridone, and Rhodium were combined with the addition of benzene-d6 and sat overnight. A paddle-wheel complex was the result of that reaction. The paddle wheel was then reacted with NAH and Deuterated Dichloromethane, and acetonitrile-d3 was added and sat overnight. As a result, the paddle wheel was hydrogenated. There was also a reaction between the paddle wheel and styrene twice, once with Deuterated Dichloromethane and once with benzene-d6. According to NMR, the conversion percentage increased over a period of time for both reactions. **Conclusion**: Many catalytic activities successfully hydrogenated and dehydrogenated the paddle wheel.

15
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Funding: NSF REU: REU-INFEWS
Project Category: Physical Sciences & Engineering

Field application of engineered biochar for the removal of phosphate from stormwater runoff

An overabundance of nutrients in natural water sources, which frequently occurs due to agricultural runoff, can lead to a process known as eutrophication. When excess nutrients are in the water it causes problems such as dense growth of algae blooms, which can lead to an increased frequency of anoxic environments and death of animal life from lack of oxygen in the water supply. Research has been previously done by Mississippi State University to help the development of an effective yet low-cost way to purify water from these contaminants. It has been determined that biochar and slag are promising materials, as they absorb and retain organic and inorganic pollutants in the water. Biochar is a carbon-rich co-product of biomass pyrolysis, and slag is a co-product of recycled steel. Both materials were proven to be effective in testing for the removal of phosphate from various phosphate solutions. Douglas fir biochar and slag are being used to build bioreactors consisting of a slag check dam backfilled with biochar leading into Catalpa Creek (StarkvilleMS). These bioreactor-filled gullies are monitored to see the phosphate level in the creek decrease in the years to come. Methods of testing are now being improved upon as the aim of this project is to upscale applications and treatments of biochar. A co-precipitation method using $FeCl_3$ and $MgSO_4$ was used to modify the surface of the biochar, creating layered double hydroxides after the addition of NaOH. Using an Inductively Coupled Plasma Mass Spectrometer (ICP-MS) to analyze phosphate adsorption data, it was concluded that treated biochar batch samples averaged about 77.93% of phosphate removal from a 5 ppm phosphate solution with an average maximum capacity of 92.23 mg/g in a 1000 ppm phosphate solution. Bioreactor samples will continue to be tested to monitor their phosphate absorption.

55
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Project Category: Biological Sciences & Engineering

The insecticide chlorpyrifos does not inactivate serine hydrolases involved in triacylglycerol metabolism in mouse heart

Chlorpyrifos (CPF) is an organophosphate (OP) insecticide linked to many health problems in humans and animals. It is known that OP insecticides inhibit cholinesterase activity to induce toxicity in the central nervous system (CNS). In our experiment, we focused on CPF's effects on the heart. We hypothesized that CPF will inhibit Ces1d activity—the mouse ortholog of human CES1. Ces1d is a serine hydrolase responsible for the hydrolysis of ester-containing molecules, such as triglycerides (TAGs). Previous work from our lab has shown that the inactivation of Ces1d can increase the levels of TAGs, cytokines, and prostaglandins in tissues and cells. Furthermore, because heart muscle relies primarily on fatty acids for energy, inhibition of TAG metabolism by CPF could also lead to altered energy production. To examine this, heart enzymes involved in TAG metabolism were treated *in vitro* with chlorpyrifos oxon, the bioactive metabolite of CPF, and Ces1d was found to be highly sensitive to its inhibitory effects (IC50 = 2.1 nM). The adult female wildtype (C57BL6) mice were treated *in vivo* for seven consecutive days with either CPF (oral, 2.5 mg/kg bw, treatment group) or corn oil (control group). Hearts were removed four hours after the last dose of CPF and flash-frozen in liquid nitrogen. We prepared heart membrane fractions from each group and performed gel-based activity-based protein profiling (ABPP) to determine whether CPF inhibited Ces1d and other serine hydrolases. The ABPP results showed that CPF did not inhibit Ces1d or other serine hydrolases including monoacylglycerol lipase (MAGL), the enzyme responsible for the degradation of the endocannabinoid 2-arachidonoyglycerol and the ultimate step of TAG degradation. Therefore, under the conditions of our experiment, we conclude that CPF does not perturb the heart enzymes involved in TAG metabolism, and it is unlikely to exert toxicity in the heart.

56
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Funding: USDA REEU
Project Category: Biological Sciences & Engineering

Water-in-oil inverse Pickering emulsions prepared by cellulose nanofibrils and their stability

The growing demand for bio-derived emulsifiers reflects a societal shift away from petroleum-based products. In this context, cellulose nanofibers (CNF) have recently emerged as a potential bio-derived Pickering emulsifier. Herein, we create water-in-oil (W/O) inverse Pickering emulsions using 2,2,6,6-tetramethylpiperidinyloxy (TEMPO)-oxidized CNF (TCNF), along with polyacrylic acid (PAA) and oleylamine (OA) as surfactants. Our aim is to study how differing concentrations of TCNF (0.05, 0.1, 0.2, 0.3 wt. %) affect the size and stability of the W/O emulsions. The aqueous phase of our emulsions consisted of various concentrations of TCNF in a 5:1 dry mass ratio with PAA. This aqueous phase was then added to a constant oil phase made up of 2.5 wt% oleylamine in toluene in an oil-to-water volume ratio of 2:1. The mixture was then emulsified by ultrasonication with an ultrasonic processor and characterized. We confirmed the formation of W/O emulsions using confocal microscopy imaging and an oil/water drop test. The effects of varying TCNF concentrations on emulsion size and stability were studied with optical microscopy and ImageJ, and storage tests were conducted to monitor changes in average droplet size over time. Less variation in droplet size over time indicated higher emulsion stability. Among the concentrations tested, we determined that the 0.3 wt% TCNF concentration was the most stable. Additionally, to gain insight into the mechanism and limits of CNF-based Pickering emulsion formation, the Pickering emulsions were made using 0.3 wt TCNF aqueous phases with varying pH from 3 to 12 and ionic concentrations from 0.05 to 0.4 M NaCl. Optical microscopy and ImageJ results showed that optimal emulsion formation was seen in pH 3-7 and that emulsion stability decreased with the presence of NaCl.

57
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Co-Author(s): Ruchitha Yadav Prakash
Funding: U.S. Army Corps of Engineers
Project Category: Biological Sciences & Engineering

Mapping Invasive Aquatic Plants Using UAS Imagery and Deep Learning

Invasive aquatic plants (IAP) are problematic in every part of the world because they endanger native plants and ruin biodiversity. Mapping where they grow is important, so that preventive measures can be put in place. Mapping of IAPs has evolved drastically throughout the last two decades. From on-foot surveys to satellite imagery, there are numerous ways to map IAPs. In this study, we will be using images collected from a UAS (Uncrewed Aerial System) with a hyperspectral sensor because of its high spatial and spectral resolution. The images are of eight distinct plants, which include alligator weed, Cuban bulrush, giant salvinia, primrose, torpedo grass, water hyacinth, water lettuce, and water lily. Remotely sensed images will be combined with deep learning models for segmentation and classification to understand the most efficient method. The deep learning models that will be studied are Mask R-CNN (Region Based Convolutional Neural Network) and SpineNet because of their strong feature extraction abilities. Mask R-CNN is a popular type of Convolutional Neural Network (CNN) that excels in high-quality image segmentation. On the other hand, SpineNet is CNN backbone that aims to retain spatial information in an image. The two models will then be trained on the images to learn features of each plant.

58
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Project Category: Biological Sciences & Engineering

Monitoring Brain Activity During Table Tennis

The 10,000 hour rule has consistently been presented as a hallmark for expertise in different subjects. This also holds true in sports, as athletes must dedicate a great amount of time and effort to become competitive and excellent at their craft. This time and effort comes from extreme amounts repetition, which leaves an alteration in brain activity, chemistry, and plasticity. This alteration can be measured through an electroencephalogram (EEG), which measures the brain's electrical fluctuations and turns it into readable data. Measuring an individual baseline alpha and beta waves are the primary interest in this experiment. Alpha waves tend to range in the 8-12 Hz range and are considered "baseline" as they are emitted at all moments while an individual is conscious. Beta waves range from 13-30 Hz, and they can signify stress and frustration. This experiment's intention is to analyze a participant's brain activity while playing table tennis. The participant is given 10 practice serves and returns before beginning a set of 100 recorded serves and returns, all while brain activity and accuracy is measured. The participant's "wins" are measured if their serve or return is observed in marked areas on the table while their "losses" are measured if their serve or return is observed outside the marked areas. The "wins" and "losses" are observed along with brain activity to determine a potential correlation. This correlation can determine optimal mental states for athletes that will create the most success. Twelve participants have been observed, with six being experts and six being amateurs. The level of experience is considered because of the previously mentioned repetition causing altered brain activity. All levels of atheletes are accounted for.

16
Name: Gregory, Noah
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Funding: NSF REU: CNS 2315855
Project Category: Physical Sciences & Engineering

Quantum Task Mapping for Distributed Heterogeneous Computing Systems

A heterogeneous computing (HC) system is an assortment of processors and cores of different varieties. It is important to schedule tasks efficiently and optimally to promote energy efficiency and prevent issues from overwhelming computer systems. When scheduling tasks onto a heterogeneous computing system, the time required to complete each task must be considered. In this research, ten classical mapping algorithms are tested against a quantum mapping algorithm to determine if the quantum is more efficient in mapping. These ten classical mapping algorithms include opportunistic load balancing (OLB), minimum completion time (MCT), minimum execution time (MET), min-min, max-min, duplex, genetic algorithm (GA), simulated annealing (SA), tabu search, and A*. Each mapping algorithm uses expected time to compute (ETC) matrices to assign every task to a machine in the algorithm's specified tactic. The ETC matrix includes expected runtime values for each task/machine pair. The heterogeneity values of tasks and machines, ranging from low to high, along with the varying degrees of consistency (inconsistent, partially consistent, and consistent), collectively influence the performance of an algorithm in relation to each ETC matrix. Quantum computers possess the remarkable capability of leveraging superposition and enabling parallel processing, which grants them the potential to solve specific problems exponentially faster. The speed advantage of quantum over classical mapping algorithms may not always be guaranteed, necessitating specific case-based testing to evaluate their respective performance. The results compared for this research are the makespan for the mapping and time each algorithm takes to complete. The makespan value is the longest runtime out of every machine. After comparing each makespan value, our research concluded that while the quantum algorithms typically would result in a proficient makespan, it was more case dependent on which algorithm performed the best and was not noticeably more efficient in this specific test.

59
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Project Category: Biological Sciences & Engineering

Exploring fluorescent wood species: Insights from the David A. Kribs wood collection

There is widespread fraud and crime associated with forest products due to the lack of experts that can quickly and accurately identify wood in the field. However, a few techniques have been developed to address this issue. One such technique involves the identification of certain wood species that display greenish-yellow fluorescence when exposed to longwave ultraviolet (UV) light. For a recent David A. Kribs Wood Collection acquisition of 2073 specimens from Michigan Tech University, we utilized a UV flashlight to detect fluorescent wood species. We inventoried 1695 wood species belonging to 770 different genera. Of these, 236 are listed on the International Union for Conservation of Nature´s (IUCN) red list in all its categories, and 49 are listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Identification of these species is critical when considering biodiversity and conservation. To this end, a method that offers simplicity and efficiency, such as fluorescence, plays an indispensable role in aiding conventional wood anatomy identification. In our investigation, we found 51 species to be fluorescent. Out of these, two are listed in Appendix II by CITES, one is listed as critically endangered, and two are listed as near-threatened by IUCN. The UV light method proved helpful in identifying fluorescent species easily and quickly. The application of this method can help prevent the illegal trade of species under protected lists by CITES & IUCN.

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Project Category: Biological Sciences & Engineering

Impact of different personal floatation devices during a simulated workload on physiological responses

Commercial fishing is one of the leading occupational sectors that lead to fatal and non-fatal injuries. Personal flotation devices (PFDs) are life-saving devices essential for commercial fishing work that include heavy workload. However, adoption and regular use of appropriate PFD is still not followed for various concerns such as restriction of mobility and comfort. The purpose of the study was to assess the impact of two different types of PFDs on physiological responses and perceived comfort while exposed to a simulated physical workload. Ten healthy participants (7 males and 3 females; 23±4 years; 78±14 kg; 176±9 cm) were assessed for different measures of heart rate (HR) and perceived subjective comfort and mobility, while wearing no PFD, an automatic minimalist PFD, and a traditional dual PFD, and performing a physical workload task of repeated lifting and placing boxes (25% of body weight) for 15 minutes. The no PFD condition was performed first followed by a counter-balanced order of the PFDs, with 10 minutes of rest. Resting, maximum, average and recovery HR in three PFD conditions were analyzed with 3×4 repeated measures ANOVA and perceived comfort and mobility scores from the questionnaire were analyzed using independent sample t-tests for the PFD conditions. Results revealed that while average and maximum HR during the workload was significantly higher than resting and recovery ($p<0.001$), significant differences between the PFD conditions were not observed. While not statistically significant, the auto PFD demonstrated better comfort ratings, along with being perceived as the least restrictive for mobility. Findings from the current study indicate that the PFDs, regardless of the type do not negatively impact HR responses when exposed to a physical workload and when compared, the minimalistic auto PFD demonstrated to be more comfortable with least mobility restriction, thus suggesting positive promotion for PFD use and adoption.

61
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Project Category: Biological Sciences & Engineering

Comparing Biomechanics of Baseball Swings Between Above- and Below-Average Hitters

Background and Purpose: Exit velocity (EV) can be used in baseball to assess hitting performance, with faster EVs indicative of better performance. Therefore, this study aimed to examine differences in hitting biomechanics during the swing for hitters with above vs. below-average EV. **Methods:** All data were collected and published freely online by The OpenBiomechanics Project performed by Driveline Baseball. Eighty-seven male participants (age 19.98 ± 2.11) of varying skill levels (12 high school, 66 college, 4 independent league, 5 minor league) performed four to nine swings. The swing with the highest EV was used for analysis. During each swing, a K-Motion hitting vest and multiple high-speed cameras coupled with fifty-five markers recorded data relating to bat and body movements. The average EV of the data set was calculated (94.77 ± 6.2 mph), and participants were then grouped into above- and below-average categories (n = 54 above average, n = 33 below average). An independent samples T-test compared body mass, height, age, bat weight and length, launch angle after contact, distance hit, pitch angle, and maximum bat, hand, upper arm, pelvis, torso, and center of gravity velocities between groups. **Results:** Body mass ($p < 0.001$), height ($p = 0.017$), bat weight ($p = 0.001$), bat length ($p = 0.001$), maximum bat speed ($p < 0.001$), and hand speed ($p = 0.038$) were all greater for the above-average group. No other significant differences existed ($p < 0.057$). **Conclusions:** These results suggest that above-average hitters are heavier, use larger bats, and have faster bat and hand speed during the swing. This possibly suggests one of the main differences between above and below-average hitters could be muscular strength. However, EV should be further studied better to understand the differences between above versus below-average hitters.

62
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Funding: NIH
Project Category: Biological Sciences & Engineering

Characterizing the DeoR Transcriptional regulator's function in *Listeria monocytogenes*.

Listeria monocytogenes is a Gram-positive and highly contagious foodborne pathogen that causes severe illness and mortality in humans and animals. It is able to survive in various stressful environmental conditions due to its complex regulatory mechanisms. The regulatory architecture includes a group of transcriptional regulators called DeoR that plays key roles in sugar metabolism. In the genome *L. monocytogenes* strain F2365, we found a total of seven members of the DeoR-family regulators including *deorF*. The specific goal of this study was to assess the importance of this transcription factor in the virulence of *L. monocytogenes* strain F2365. In this study, An *L. monocytogenes* strain lacking *deorF* (*ΔdeorF*) and complemented strain were constructed. To determine the role in vivo, 10–12-week-old female Balb/c mice were injected with *ΔdeorF* strain and bacterial loads were determined at 72 hours post-infection. Intracellular replication was tested in J774A.1 macrophage cell whereas plaque formation was tested in murine L2 fibroblast cells. Furthermore, biofilm formation and oxidative stresses were assessed using BHI supplemented with glucose and H2O2, respectively. Following intravenous infection, animals infected with *ΔdeorF* strain exhibited 1.7 and 2.3 log10 decreased bacterial CFU in spleens and livers compared to animals infected with wildtype F2365 strain. The *ΔdeorF* showed a significant impact on plaque forming and intracellular replicating abilities compared to the wildtype F2365. The biofilm-forming abilities of *ΔdeorF* is significantly impacted. Furthermore, the oxidative stress response of *ΔdeorF* is found to be significantly impacted on exposure to 10- and 15mM H2O2. This study shows that members of the *deorF* play a significant role in *L. monocytogenes* virulence, cell-to-cell spread, biofilm, and oxidative stress response. Further investigation of the mechanisms utilized by the *deorF* to exhibit the tested mechanisms will aid in the development of control and preventative strategies that are translatable to other foodborne pathogens.

94
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Funding: ORED Undergraduate Research Program
Project Category: Social Sciences

Racial Differences in the Long-Term Impact of Parental Incarceration on Depression

Although parental incarceration is an important societal issue, there has been little work done to understand the long-term impacts of this experience on children as well as the race and gender differences in these impacts. This is especially concerning considering many incarcerated individuals are from minority groups. To better explain the impacts of parental incarceration, theories with more longitudinal capability should be utilized. This study advances previous research by focusing on race and gender differences in parental incarceration as well as the long-term impact of parental incarceration. Consistent with current literature, it was predicted that parental incarceration will be associated with greater levels of depression. Additionally, this association will be stronger for early-life parental incarceration. In terms of race and gender, black individuals and same-sex dyads will demonstrate the strongest relationship between parental incarceration and depression. Data analyses were completed using Waves I through V of the National Longitudinal Study of Adolescent and Adult Health survey data. Using two-sample t-tests and Chi-square tests, we found three key findings. Our first key finding was that parental incarceration was strongly associated with greater levels of depression. However, the timing of parental incarceration was not a significant moderator to this relationship. Our second key finding was that race may not be an important factor, as white participants reported the strongest association between parental incarceration and depression. Finally, our third finding was that gender was important only for mother-daughter dyads. These results suggest that there may be more complex factors contributing to these relationships than has been previously discussed in the literature. Future research would benefit from controlling for other negative life outcomes as well as conducting comparative analyses involving childhood and adulthood measures of depression.

17
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Project Category: Physical Sciences & Engineering

Spin Singlet Stability for 1/2 Spin Heiseinberg Spin Rings

For the quantum Heisenberg spin-j model on a bipartite, balanced graph, the ground state of the antiferromagnet is a spin singlet by the Lieb-Mattis theorem, "Ordering of energy levels." Moreover, the minimum energy in the spin S sector E(S) is monotonically increasing as S moves from 0 to j|V|. The Lieb-Mattis theorem also implies that for the ferromagnet the absolute ground state is EFM0 (Smax). However, their theorem does not necessarily imply that E(j|V|) is monotonically decreasing as a function of S for the ferromagnet, as one might expect. We use the tool of first-order perturbative linear spin wave theory, and show that in that context E(0) < E(1). This is modelled on the Lieb-Schultz-Mattis theorem about gapless spin systems. This tool is applicable for sufficiently "long" systems, such as long spin rings, in the presence of a spectral gap. For spin j = 1/2, all this was already proved by Sutherland, using the Bethe ansatz. But we present numerical evidence for spin rings for j > 1/2, as well.

63

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Funding: MSU Grant# G00007717
Project Category: Biological Sciences & Engineering

Risk Assessment Using Machine Learning for Aflatoxin Contamination in Corn

Aflatoxins are a class of mycotoxins produced by the fungus, Aspergillus flavus, that can grow in the seeds of a number of important agricultural crops including corn (Zea mays). Under certain environmental conditions such as high temperature and humidity, conditions present in Mississippi, the fungus tends to produce high levels of aflatoxins in corn cobs. Due to their carcinogenic nature, aflatoxins can be harmful to animal and human health and cause direct economic losses. The goal of this project was to create an aflatoxin contamination model for corn that stakeholders can use to assess investment risk. Historical aflatoxin contamination data (2008-2018) in corn was used to train a predictive model. Currently, there are models trained for other states that can predict risk for aflatoxin contamination. However, there are no models predicting aflatoxin outbreaks in Mississippi. This project centered on gathering data pertaining to Mississippi and training the model for Oktibbeha County. To train the model, first aflatoxin data collected from field samples was gathered. Then, using Google Earth Engine, several satellite datasets (TIGER, PRISM) were pulled to gather NDVI (normalized difference vegetation index), temperature (minimum and maximum), and precipitation data. This data, in combination with crop yield and historical aflatoxin contamination levels, was then used to train the mechanistic model to predict aflatoxin contamination. The model's predictions included engineered features such as fungal growth and aflatoxin risk index, which combines environmental parameters with growth curves to create input features used for predictive model training. The model in this project was a proof of concept, using Oktibbeha County because of the available data. The long-term goal is to expand the study and gather data for the entirety of the state, creating a model covering all of Mississippi to aid farmers and stakeholders in risk management of their crops.

18
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Funding: NSF REU: CCS
Project Category: Physical Sciences & Engineering

Effect of Silanol Nest Defects on Solvation Structure and Dynamics in Lewis Acid β-Zeolite with Machine-Learned Force Field.

Due to the urgency of the negative economic and social impacts of climate change, it is crucial to develop cost-effective processes to produce value-added chemicals and fuels from renewable sources. Lewis acid zeolites are a promising catalyst for the hydrothermal processing of lignocellulosic biomass into fuels and chemicals. While it is known that silanol nest defects in Lewis acid zeolites alter catalyst activity and selectivity, an atomistic understanding of the structuring and dynamics of solvents near the active site with and without defects is limited. In this work, we develop machine-learned forcefields (ML-FFs) to model the reactive diffusion of methanol and water in Sn-BEA zeolite with and without silanol nest defects with large-scale reactive molecular dynamics (MD). This force field is developed by training a sparse Gaussian process on ab initio MD trajectories and enables reactive MD without the need to fit a complicated reactive force field. Preliminary results show that these force fields enable the simulation of systems that are twelve times larger in size compared to what is computationally tractable with ab initio MD and results in a 2,000-fold improvement in the amount of time required per MD step. This research provides an atomistic description of the solvation dynamics and environment near Lewis acid sites and demonstrates the utility of ML-FFs for liquid-phase zeolite catalysis.

19
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Funding: NSF REU: Food, Energy, and Water Security
Project Category: Physical Sciences & Engineering

Low-cost adsorbents and fertilizers for phosphate adsorption and nutrient delivery

Fertilizers are a necessary and fundamental aspect of the agricultural process. With the global population rising each year, more fertilizers are needed to keep up with agricultural demands. Commercial fertilizers are highly water soluble and contribute to eutrophication caused by nutrient runoff that pollutes bodies of water. There is an ever-growing need for a low-cost, greener alternative that will provide plants with necessary nutrients at a controlled rate. Rice husks, a major agricultural waste product in the U.S., have a variety of potential uses. Rice husk biochar has a high silica content that can retain more moisture than other biomaterials. In addition, it has a higher surface area and larger pore volume that allows for better chemical retention when treated. Four samples of rice husk biochar were obtained from Glanris which were pyrolyzed at 400 °C in a low oxygen environment for 10-15 minutes residence time. The biochar samples were modified with deposition of a) $MgFe_2O_4$, b) Fe_3O_4, c) $MnFe_2O_4$, and d) $BaFe_2O_4$ nanoparticles onto the biochar surface which increased phosphate uptake. Column leaching experiments (2.54 cm dia x 9.31 cm height) were carried out by passing 10 L of deionized water through phosphate-adsorbed engineered biochar-loaded sandy loam soil mixture (100 kg of P_2O_5/hectare) and compared with a triple super phosphate loaded soil matrix (100 kg of P_2O_5/hectare). These modifications decreased the phosphate leaching rate compared to triple superphosphate. Finally, the original rice husk biochar samples were characterized and compared to the engineered rice husk biochar. The characterization studies included: point of zero charge, X-ray diffraction, Fourier transform infrared spectroscopy, X-ray photoelectron spectroscopy, and elemental ash analysis.

20
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Project Category: Physical Sciences & Engineering

Scanning Tunneling Microscopy Imaging of Poly(3-hexylthiophene) on Au (111) surface: Enhancing Optoelectronic Device Performance

Studying conjugated polymer properties and energy conservation enables advancements in affordable, lightweight, and flexible optoelectronics. Specifically, Poly(3-hexylthiophene) (P3HT) has become a prominent component in optoelectronics due to its high field-effect mobilities, on/off modulation, and structural features. To gain a deep understanding of the chemical conformation and self-assembling mechanism under atomic resolution, a high-quality and repeatable self-assembled monolayer of P3HT is required, which is challenging due to aggregation. This research project investigates how conjugated polymers assemble on specific solid surfaces. The research methodology involves sample preparation using the hydrogen gas flaming technique to reconstruct the Au (111) surface. This results in an atomically flat and pristine surface for improved scanning tunneling microscopy (STM) imaging. Electrospray deposition is employed to deposit P3HT on the Au (111) surface under controllable conditions. STM is utilized to acquire images at high spatial resolution, which can be observed as crystallized domains as well as randomized curvy structures. These results provide molecular-level insights into critical properties of P3HT, such as persistent length and inter/intra-chain interactions. Further developing the ability to tune the self-assembly processes via environmental control will open avenues to understanding a wide range of conjugated polymer systems at the molecular level. The broad impact of this project lies in the potential to develop optoelectronic devices with improved electrical properties and capabilities.

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Project Category: Biological Sciences & Engineering

Investigating the Effect of Adipocytes on Triple Negative Breast Cancer Cells

Introduction: Triple Negative breast cancer (TNBC) accounts for approximately 15% of worldwide cases of breast cancer. It is a malignancy that does not present with any of the commonly found receptors (estrogen, progesterone or human epidermal growth factor receptor 2) on breast cancer cells. As a result, the standard treatment pathways targeting these receptor sites cannot be employed. TNBC has been known to present at a higher rates in patients with obesity, which can be attributed to the relationship that exists between adipocytes and cancer cells. The 4T1 cell line is a widely employed model for TNBC. It is established that introduction of 4T1 into the lipid rich murine mammary gland results in aggressive cell behavior: high tumorigenicity, invasiveness, and spontaneous metastasis to other predominately adipocyte-dominated host environments. **Hypothesis:** In this study specifically, we wanted to investigate the effect of adipocyte cells, a type of stromal cell that is composed of a single lipid droplet, which are abundant in the breast and provide the lipid content needed for an ideal tumor microenvironment, on 4T1 breast cancer cells. We hypothesized that the adipocyte-dominated host environments of the breast will support cancer cell proliferation and migration. **Methodology:** 3T3-L1 preadipocytes were first converted to mature adipocytes. The maturity of the adipocyte cells was confirmed via Oil Red 0 staining as well as protein marker analysis. The pre- and mature- adipocytes were then co-cultured with 4T1 cells in a three-dimensional collagen gel matrix. A control group of the 4T1 cells were cultured with media only. **Results and Conclusion:** Our results indicated that when cultured with matured adipocytes, the proliferation and migration of 4T1 cells was increased which indicates that mature adipocytes in the tumor microenvironment play a critical role in regulating the function of breast cancer cells.

21
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Project Category: Physical Sciences & Engineering

Solving the 1D Infinite Potential Well on a Quantum Computer Using Second Quantization and the Adiabatic Theorem

One of the several applications of quantum computing is the performance of simulations in nuclear and particle physics. The required simulations usually involve large amounts of data which makes it a difficult task for a classical computer. On the other hand, a quantum computer is essentially made for simulating quantum mechanical systems. They can solve the complicated problems that arise such as the fermionic sign problem in Monte Carlo simulations and can allow us to calculate the real-time dynamics of a many-body system. In this project, we employ the methods of quantum computing to solve a simplified version of a complex nuclear interaction, with the goal of learning and understanding the mechanisms of Trotterization and discretization. On a quantum computer, an initial state comprised of various qubits is positioned on a one-dimensional lattice with some finite size and bounded by two walls at the ends of infinite size. The space of the lattice is discretized in integer steps using the language of second quantization quantum mechanics and the system is evolved in integer steps of time via Trotterization. The problem was then to solve the time-dependent Schrodinger Equation for the one-dimensional infinite well through unitary evolution for different initial states and analyze each one of the outcomes.

65
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Project Category: Biological Sciences & Engineering

Unlocking the Doo Doo World

Aggregative multicellularity, defined as the formation of several individual cells into macroscopic dispersion structures known as fruiting bodies, is a key ecological milestone that has occurred independently across various eukaryotic lineages. Copromyxa (Amoebozoa), Guttulinopsis (Rhizaria), and Sorodiplophrys (Stramenopiles) are three non-model microbial eukaryotes that live inside herbivore feces and are among the rare organisms that demonstrate this social behavior. Despite their interesting character, we know very little about their cellular biology and the underlying mechanisms of their behavior. We focused our efforts in this work on Guttulinopsis vulgaris, which we recovered from cow dung at the Mississippi State extension. A key obstacle in researching this organism is the lack of a clear dung-based media, because we discovered that Guttulinopsis loses its ability to aggregate in the absence of dung. To solve this, we created DPAclear (dung tea), which allowed us to see individual Guttulinopsis cells aggregating and developing a fruiting body for the first time. The aggregation process begins with a small group of 5-10 cells congregating at a single site, according to our findings. Surprisingly, a few cells then commit cellular "suicide," encouraging hundreds of additional cells to swarm to the same location. Our repeated observations of this mechanism have influenced the construction of a novel model of multicellular growth in Guttulinopsis. The discovery of this type of altruistic cell suicide as a technique of intercellular communication might have profound implications for our knowledge of eukaryotic cell biology and behavior. Our findings highlight the importance of researching non-model species and open new avenues for investigating the principles that govern social cell behavior in eukaryotes.

95
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Project Category: Social Sciences

Explaining comorbidities between borderline, substance, and alcohol use disorders: Investigating the potential shared risk factors of parental invalidation and childhood emotional sensitivity

Childhood emotional sensitivity and parental invalidation are primary risk factors for the development of borderline personality disorder (BPD; Linehan, 1993), a disorder highly comorbid with substance/alcohol use disorders (Trull et al. 2018). The assessment of shared risk factors is lacking. Examining childhood sensitivity and parental invalidation as potential risk factors for alcohol/substance use may provide valuable insight into explaining the comorbidity rates between BPD, SUD, and AUD diagnoses. Subjects: Starkville community members (n=101) with an age range 18-35 [M=21.65; SD=4.05]). Method: Participants completed the SCID-5 (Powers & Petri et al., 2022) and the SCID-5-PD (First et al., 2016) to assess Drug and Alcohol Use Disorders and BPD. They also completed three self-report measures: The Five Factor Model Borderline Inventory – Short Form (DeShong et al., 2016), the Emotion Vulnerability-Child (EV-Child; Sauer & Baer, 2009), and the Socialization of Emotion Scale (SES; Krause et al. 2003). Results: BPD was significantly correlated with both risk factors. SUD was significantly correlated with parental invalidation only ($r=.27$, $p < .05$). AUD was not significantly correlated with either childhood risk factor. When assessed in regression analyses, both risk factors were significantly associated with the FFBI-SF ($\beta=0.47$, $p<.001$ and $\beta=0.27$, $p=.004$ for emotional vulnerability and parental invalidation for the FFBI) and with the SCID-5-PD BPD. (Odds rations were 1.043 (95% CI=[1.01.1.08]) and 1.01 (95% CI=[0.999, 1.028]) for emotional vulnerability and parental invalidation). For SUD, parental invalidation was the only significant predictor (OR=1.01; 95% CI= [1.001, 1.02). Neither risk factor was a significant predictor for AUD. Conclusions: Emotional vulnerability and parental invalidation remain clear precursors for BPD, but do not necessarily explain the comorbidity rates between BPD and alcohol/substance use. Additional research on other potential shared risk factors is needed to explain the overlap between these disorders.

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Project Category: Biological Sciences & Engineering

Model for Therapeutic Development in Traumatic Brain Injury

Traumatic brain injury (TBI) is one of the most frequently occurring injuries with approximately 250,000 injuries and 69,000 deaths annually in the United States. TBI occurs when a forceful blow or whiplash induces damage in the brain. After the injury occurs, the timing of the treatment can be crucial to successful recovery and delayed treatment can have drastic physical, cognitive, and socioeconomic effects. The availability of therapeutics that can be rapidly administered post-injury is also important. The purpose of this research is to develop novel therapeutics to treat TBI that can be administered as a nasal spray formulation thereby allowing rapid administration quickly after diagnosis of a concussion. Thus, a model for TBI needs to be developed that can be utilized to further the research. To achieve this, we utilized a user-friendly platform weight-drop device that can induce TBI in a rat without surgical or pre-injury manipulations. Following anesthesia, 54 adult male rats were administered impact levels of either Sham (no impact), 0.5J, 1.0J, 1.5J, 2.0 J, or 2.5J with 9 rats per group. Post-impact, the rats are given pain medication and anti-sedatives. At 3, 7, and 14 days, 3 rats per impact level were sampled and the hippocampus and cerebral cortex were collected. The use of western blot analysis allowed the quantification of the levels of neuron-specific-enolase (NSE), a marker for neuronal damage, and of glial fibrillary acidic protein (GFAP), a marker for astrocyte activation. Maximum GFAP levels occurred 7 days post-impact. However, maximum NSE levels occurred on day 3 post-impact. Both markers increased as the impact level was raised but reached a plateau at higher impact levels. Based on the experiment, the impact level of 2.0J was decided to be the optimum level that will be used in future experiments to treat TBI.

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Funding: NSF REU: Food, Energy, and Water Security - Chemistry Department
Project Category: Physical Sciences & Engineering

Use of calcium alginate hydrogel coated phosphorous enriched Douglas fir biochar as a controlled release fertilizer

In recent years, sustainable crop production has been in high demand to supply the growing population. However, excessive fertilizer usage leads to an increase in runoff, leaching, eutrophication, and environmental pollution, affecting the decrease in crops and plant production. The emergence of hydrogel composites in agricultural applications is a promising approach to maintaining sustainable cultivated practices by implementing the vital controlled release of nutrients. In this study, a controlled-release fertilizer was prepared using Douglas fir biochar (BC) treated with potassium phosphate monobasic (KH_2PO_4) and calcium chloride ($CaCl_2$) at pH 10. Then, this calcium phosphate-modified BC was coated with hydrogels by mixing with sodium alginate and $CaCl_2$ at room temperature. This hydrogel-coated material plays a vital role in releasing nutrients to the soil in a controlled manner. The resulting fertilizer composite (CPBC) was characterized using numerous techniques including XPS (X-ray photoelectron spectroscopy), SEM (scanning electron microscopy), XRD (X-ray diffraction), TEM (transmission electron microscopy), FT-IR (Fourier transform infrared spectroscopy), BET (Brunauer−Emmett−Teller) measurement, and PZC (point of zero charge). The release behavior of phosphorus (P) at different pH values was analyzed using ICP-MS (inductively coupled plasma mass spectrometry) to observe the sustained release of phosphorous from fertilizer. Subsequently, a greenhouse experiment was conducted using corn plants (*Zea mays*) for 35 days with experiments against triple superphosphate as standard fertilizer, and calcium phosphate-loaded biochar. The chlorophyll content and plant height were measured during the greenhouse period, and nutrient uptake was measured after harvesting to evaluate the P uptake of this novel, eco-friendly, and low-cost fertilizer.
Keywords: fertilizer, controlled release, sodium alginate, hydrogel, coating, P uptake

96
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Project Category: Social Sciences

The Impact of Social Media and Body Image: Exploring the Relationship between Exposure to Idealized Body Images and Identity

Social media is constantly growing and has become an everyday part of life for most people around the world. However, there is a growing concern that social media is the catalyst for the decline in body image perceptions of young individuals, ultimately causing a decrease in mental health. There have been many studies over the past several years focusing on this growing issue, but as social media advances there is a growing need for more studies so that solutions can be proposed to alleviate the issue. As young individuals, we felt that it was important to study the relationship between social media and body image perceptions in young people as this issue affects all of us. We decided to study 20 participants, both male and female, from the ages of 18-25 who are actively engaged in social media, who come from different racial, ethnic and economic backgrounds. We felt it was important that our participants be active on social media so that our data would be more accurate. We had our participants partake in pre- and post- test surveys using Likert-scales to get a measure of their social media usage, ideal body type, etc. as well as an experimental section where participants were broken into 4 different groups and given a “mock social media” platform with controlled content in between both surveys. Our findings revealed that there is a distinct relationship between social media and the dissatisfaction of body image perceptions of young people. Additionally, our data suggests that social media affects body image perceptions of young women more than young men. Our data from our study proves our hypotheses to be correct in suggesting that social media has a direct negative effect on the overall dissatisfaction in body image perceptions in young individuals, which increases the decline in their mental health.

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Project Category: Biological Sciences & Engineering

Unleashing the Power of the Brain: Exploring Cognitive Activity in E-Sports.
This study explores the cognitive activity of video gamers, examining the correlation between winning versus losing and analyzing the differences in EEG Alpha and Beta power among amateurs and experts. This study aims to shed light on the cognitive benefits of video gaming, providing insights that can be utilized to enhance the training experience for e-gamers. The electroencephalogram (EEG) measures real-time cognitive activity in the brain. To explore the impact of cognitive activity on whether the participants win or lose, 12 participants, consisting of six amateur and six expert video gamers, were recruited to play Super Smash Brothers on a Nintendo Switch. The experiment was designed based on the participant's experience level, with the CPU and difficulty level adjusted accordingly. The participants' baseline psychological state was obtained with eyes open and closed for two minutes before completing ten practice trials and recording 60 trials in two hours while their winning versus losing ratios were being recorded. MATLAB was used to analyze the frequency response through power spectral analysis. The aim of this analysis is to observe any trends related to the power of the frequency bands. With this new perspective, approaches using brain activity associated with winning can enhance the training experience with positive results. Overall, this study sheds light on the cognitive differences between amateur and expert video gamers and provides valuable insights into the impact of winning versus losing on cognitive activity. The results of this study can be utilized to improve the training experience for e-gamers/athletes, and to understand the neural mechanisms that underlie the cognitive benefits of video gaming.

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Project Category: Biological Sciences & Engineering

APEX Model-Based Analysis of Rainfall and Soil Water Storage on Soybean Leaf Area Index, Biomass and Yield

Accurate estimation of crop yield using spatiotemporal data is crucial for effective crop production management decision support. This study aims to quantitatively analyze the influence of rainfall patterns, LAI (leaf area index), soil water storage, and biomass on soybean yield. The research utilized the APEX (Agricultural Policy/Environmental eXtender) model, incorporating various databases including soil, weather, crop, field management, and spatial location data. Based on the rainfall during the growing season, each year was categorized as either dry, wet, or normal. Soil data from Gridded Soil Survey Geographic Soil Map (gSSURGO-30) and crop data from Gridded Cropland data layer (CDL-30m) were overlaid and clipped in ArcGIS software to define the study area. Noxubee County, Mississippi, was selected as the study region for this research. The 30m resolution of Cropland data layer was aggregated to fit into 1km resolution of Daymet weather data (https://daymet.ornl.gov). The APEX model simulated soybean yield, LAI, biomass, and soil moisture content over a 43-year period. The APEX model estimated soybean yields of 2.18 Mg ha-1, 3.65 Mg ha-1, and 3.27 Mg ha-1 for the dry, normal, and wet years, respectively, compared to USDA NASS reported yields of 2.0 Mg ha-1, 3.76 Mg ha-1, and 3.7 Mg ha-1. The root mean square error values for APEX model predictions were 0.18, 0.11, and 0.43 for the respective years. The model outputs provided insights into immediate water availability for soybean growth at different scales and depths with water availability being greater at vegetative stage than reproductive stage. Further, we will aim to analyze the effect of LAI, biomass on soybean yield across the vegetative and reproductive growth stages of soybean. The study findings enhance our understanding of the effects of extreme weather conditions, such as floods and droughts, on soybean yield and provide APEX Model estimates of soybean yield.

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Project Category: Physical Sciences & Engineering

Photochemistry of Aromatic Imides: Synthetic Potential and Radical Anions in Aqueous Solution

Aromatic imides show a wide range of photochemical activity. Phthalimides can cyclize and form medium to large rings upon irradiation in aqueous solution, tolerates several functional groups and gives excellent yields. This decarboxylative photocyclization of phthaloyl ω-carboxylic acids is a triplet biradical reaction that can even force cyclohexane into unfavorable boat conformation. Pyromellitimide (1,2,4,5-Benzenetetracarboxylic acid diimide) is widely used in polymeric films (Kapton) due to its high thermal stability, good mechanical properties, low dielectric constant, low coefficient of thermal expansion and high radiation resistance. Additionally, the characteristic absorption of the radical anion at 720 nm makes pyromellitimide an attractive component of electron-transfer cascade systems. Pyrolmellitic imide also undergoes the decarboxylative photocyclization, even though the preparative value is limited due to the large number of regio- and stereoisomers formed. Conveniently, the reaction can be monitored via UV/Vis spectroscopy by the radical anion absorption at 720 nm. The photochemistry of mellitic imides has so far not been investigated. Even the synthesis of the mellitic imides is not as straightforward as for other imides. Here we report our progress on the synthesis and photochemistry of mellitic imides with ω-carboxylic acids.

24
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Project Category: Physical Sciences & Engineering

Reproducibility of drift gas modifier effects in ion mobility spectrometry

Ion mobility spectrometry (IMS) is a gas-phase separation technique that can be used to gain additional structural information about analyte ions on mass spectrometry platforms. Because IMS separates ions based on their shape rather than their mass, it can, in principle, be used to differentiate isomers; however, this is challenging for many small molecules. Drift gas modifiers (DGMs) offer a potential avenue for enhancing separation of small molecule isomers if the isomers are differently affected by the presence of the DGM. Previous work with DGMs has been done on custom-made instrumentation, showing the approach to be promising. The goal of this work is to investiagte (1) whether the previously reported effects can be reproduced on a comercially-available instrument and (2) the inter-day and inter-user reproducibility of these effects. Such reproducibility is critical for the approach to be analytically valuable. Six model analytes will be studied (valinol, tryptophan, ethanolamine, atenolol, serine, and salbutamol) with two DGMs (ethyl lactate and 2-butanol) under several instrumental conditions. The change in drift time was calculated for each analyte and DGM pair across several replicate measurements; the calculated changes in drift time were then compared to previously obtained data from the literature and other data collected in our laboratory to characterize reproducibility.

69
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Project Category: Biological Sciences & Engineering

Initiation of a standard soil-block test to evaluate wood preservative treatments

The American Wood Protection Association (AWPA) sets standard tests for evaluating wood products. This study applied E-10, a test for wood preservative response against wood decay fungi. Soil was distributed into glass containers at the volume specified in the test standard, 118 mL. The water holding capacity for the soil was determined, and 44 mL of sterile water was added and allowed to percolate. Soil containers were sterilized before adding a 1-inch by 1-inch southern yellow pine feeder strip. *Gloeophyllum trabeum*, a brown-rot wood decay fungi, was grown on agar plates. Sections of 1cm2 or less were cut from fully covered fungi plates and added to the soil surface at each edge of the pine feeder strip. Soil jars with fungi were incubated and allowed to grow until the fungi covered the pine feeder strip. Blocks with wood treatments were placed on top of the fungi and the test will continue for up to 24 weeks.

25
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Project Category: Physical Sciences & Engineering

Immoboilization of Lead and Arsenic from soil using modified biochar

Lead and arsenic levels in soil have been continuously increasing due to their non biodegradability, leading to soil pollution and subsequent absorption by growing plants, which poses a health risk to humans upon consumption. Consequently, the immobilization of these substances becomes imperative. To address this issue, the incorporation of magnesium phosphate onto the surface of Douglas fir biochar was achieved through the coprecipitation method, utilizing magnesium nitrate and dibasic potassium phosphate salts. The point of zero charge for unmodified and Mg3(PO4)2 modified biochar were 7.35 and 7.48 respectively. The soil samples used in this study were collected from North Farm Mississippi State, with respective CEC values of 4.48 and 7.4. Arsenic and lead salts were spiked into the soil with a concentration of 361.56 mg/kg and 250 mg/kg respectively, while unspiked soil served as the control. Additionally, conductivity tests at different pH levels were performed on the contaminated soil, as well as on the modified and unmodified biochar. The results exhibited a discernible disparity between the effects of the modified and unmodified biochar, whereas the impact on the As and Pb in the soil showed little or no significant difference. The efficacy of the modified biochar in immobilizing the contaminants was assessed through a replicated greenhouse experiment, with measurements of plant height and chlorophyll content recorded at regular intervals of 7, 14, 21, and 28 days. On the 35th day, the plants were ground, and detailed comparisons and further characterization were conducted. Notably, this study's novelty lies in the ability of the magnesium phosphate-modified biochar to effectively immobilize contaminants while also serving as a nutrient source for plant growth.

70
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Project Category: Biological Sciences & Engineering

Characterizing the Reproductive Tract Microbiome in Broiler Breeder Hens in Relation to Age

In poultry, meat production and reproductive performance has a negative relationship, one will decrease the other. Therefore, alternate routes for improving broiler breeder reproductive performance need to be investigated to avoid disrupting the meat production in broilers . One area that is unexplored is the microbiome within the reproductive tract and how they vary depending on the stage of production. Scientific evidence indicates that in humans and agricultural animals including poultry, reproductive microbiome can be used as a good indicator of reproductive traits such as semen quality, fertility, and progeny performance. Therefore, objectives of this study were to characterize the microbial composition of different segments of the reproductive tract and to identify the relationship between reproductive tract microbiome and age in broiler breeders. Twenty broiler breeder hens of two different age groups, 25 and 33 weeks of age, were obtained from a commercial primary breeder, such that they were from the same genetic origin (n=10hens/age). For sample collection, each bird was humanely euthanized by CO2 asphyxiation, abdomen opened, and the entire reproductive tract was aseptically removed. Then, the mucosal surface of each part of the oviduct (magnum, isthmus, uterus, and vagina) were aseptically scraped and suspended in 1 mL sterile 1X PBS. Immediately after collection, samples were stored at −20°C until DNA extraction. Then, microbial genomic DNA was extracted from each sample using a commercially available DNeasy blood and tissue kit. The samples were then analyzed by 16S rRNA amplicon sequencing to define the microbial composition across different sections of the oviduct. To determine the community differences within and between microbiomes, Alpha and Beta diversities were calculated using QIIME 2 software. Differences in the microbiome composition between different segments of the oviduct were determined by ANOVA and PERMANOVA using the R-software. Using Chao1, older broiler breeder hens (age 33) were found to have an Alpha diversity higher than the hens of 25 week ($P < 0.0001$). Chao1 was also used to determine diversity between the segments within the same age: for 33 weeks, the vagina appeared to have the most Alpha diversity ($P = 0.03$) compared to the other segments. However, for 33 weeks of age, there was no bacterial Beta diversity found; similarly, for 25 weeks of age, there was no bacterial diversity found between the segments for Alpha or Beta diversities. With Beta diversity, using PCoA, younger birds (age 25) were found to have a larger number of bacterial diversity ($P = 0.001$) than birds of 33 weeks of age. When comparing the relative abundance of microbiomes between the different ages, both groups have large abundance of Firmicutes, Proteobacteria, and Bacteroidetes. However, the older group has higher relative abundance of Cyanobacteria, Fusobacteria, and Spirochetes ($P = 0.001$). In conclusion, bird age has a very significant effect on bacterial community diversity. Older birds (age 33) have higher oviduct bacterial diversity than young birds (age 25); and bacterial communities are largely structured based on age than oviduct regions.

26
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Project Category: Physical Sciences & Engineering

Understanding Deep Neural Networks as a Multilayer Graph: An Entropy Perspective

The primary objective of this research is to enhance comprehension of deep neural networks in geometric perspective. This study focuses on the analysis of conventional neural networks using a graph-theoretical framework. The main aim of this study is to examine the correlation between the performance of a neural network and its geometric characteristics. The interconnections among neurons within these networks are depicted as edges, while the weights assigned to these interconnections. In order to capture the behavior of these networks regarding quantitative structural metrics, the derivation of the spectral entropy of the adjacency matrix and the entropy of weight distribution is undertaken. The results of a series of experiments demonstrate a clear trend of decreasing entropy metrics as the training process advances. This discovery indicates a positive association between high entropy and high performance.

The current investigation proposes the inclusion of entropy as a component of the loss function in the training phase, aiming to expedite the convergence of the neural network. The incorporation of entropy into the loss function has the potential to improve the training process, resulting in faster convergence. The decrease in entropy signifies a decrease in the overall degree of disorder or randomness within the neural network, indicating an improvement in its organization and effectiveness in encoding information. The elucidation of this phenomenon may be achieved by employing the theoretical framework of the "edge of chaos," which provides an explanation for the emergence of intelligence.

71
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Project Category: Biological Sciences & Engineering

A preliminary study of the effect of dietary cottonseed on the follicular reserve of does artificially infected with Haemonchus contortus

Studies have reported the negative effect of cottonseed (CS) gossypol on the ovarian reserve of the follicles, impairing female fertility. This study evaluated the potential effects of CS as a source of gossypol in combination with a parasitic infection on ovarian follicular reserve in meat goats. Forty (n=40) Boer x Spanish cross does, consuming hay, were randomly subjected to cottonseed (CS+, 0.5% body weight) or concentrate (CS-) supplementation and parasite infection (P: *Haemonchus contortus*) in 2x2 factorial arrangement with treatments being CS-/P-; CS+/P-; CS-/P+, and CS+/P+. After ten weeks, animals were slaughtered, and the ovaries of each treatment were fixed with formalin and subjected to histology staining. Cuts of one left and one right ovary of two does were placed on microscope slides, and 48 slides were subjected to a microscope visualization (EVOS FL Auto; 20x). Primordial follicles (PF) were classified as healthy (stained nucleus), unhealthy (pycnotic), and undetermined. Data were analyzed with ANOVA 2 and expressed as mean ± sem. A total of 20,562 PF corresponding to 10,410 (50.6%) healthy; 3,729 (18.1%) unhealthy; and 6,909 (33.6%) undetermined were examined; of which 26%, 20%, 31%, and 23% of the total PF belonged to the CS-/P-, CS-/P+, CS+/P-, and CS+/P+ treatment groups, respectively. A higher ($P<0.05$) number of PF were counted on left vs. right ovary sections (11,584 vs. 8,978). Averages of 121±6 vs 101±6 PF were calculated per left and right ovary sections. CS+/P- had an increased number of PF per section, while parasite infection decreased these numbers ($P<0.05$; CS-/P+ and CS+/P+). Regardless of the treatment group, the proportion of healthy follicles (48.3%) was significantly higher than the unhealthy (18.1%), and undetermined (33.6%). It was concluded that dietary cottonseed and parasitic infection inversely affect ovarian follicle reserve, while the proportions of healthy follicles were unaffected across treatment groups.

72
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Project Category: Biological Sciences & Engineering

Investigating Primary Metabolites Produced by Soybeans Exposed to Botic and Abiotic Stressors.

With the ever-present threat of climate change due to the anthropogenic production of greenhouse gasses, food production and crop viability have become exceedingly important areas of research; vital crops such as soybeans will be exposed to new and more extreme abiotic and biotic stresses such as drought and pathological infection. One economically important pathogen in agronomic and horticultural crops is *Macrophomina phaseolina (Tassi) Goid.*. This fungus is extremely hardy due to the production of microsclerotia, and it thrives in hot and dry conditions. Given *M. phaseolina* can infect over 500 species of plants, methods of mitigating its disastrous spread are a high priority. In response to stress, plants exhibit alterations in their metabolic pathways, which potentially make them more susceptible to pathogens such as *M. phaseolina*. However, the exact mechanisms of this dynamic response have yet to be fully elucidated. Understanding the relationship between the metabolome and independent and combined stressors is essential to minimizing current and future crop loss. In this study we explore the impact of two key stressors: drought and *M. phaseolina* infection. Four treatments were applied to soybean (*Glycine max (L.)* Merr.), and various observable morphological evidence such as height and internodal distance were collected to evaluate the impact of these two stressors on soybean growth and health. Additionally, 500 MHz 1H NMR spectroscopy was utilized to evaluate the metabolomic alterations in soybean plants due to *M. phaseolina* infection. With this data we hope to understand the effects these stressors have on soybean metabolism, and to determine how these confounding stressors may serve as biomarkers for breeding selection of plants with enhance stress tolerance.

73
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Project Category: Biological Sciences & Engineering

Occupational Skin Diseases (Atopic & Contact Dermatitis) In Wood Products: A Literature Review

Occupational Skin Disease is a skin disease caused by exposure to work hazards. Examples of forest industry sites that may contribute to this disease include paper manufacturing, wood products manufacturing, adhesive processing, and furniture making. Dermatitis is a term that describes red, inflamed, often dry, and itchy skin. There are two types of dermatitis, and they are 1) atopic dermatitis and 2) contact dermatitis. Atopic dermatitis is chronic or long-lasting and occurs at any age. Contact dermatitis is when the skin becomes inflamed when it comes in contact with something that causes an allergic reaction. This research aims to understand how people diagnosed with dermatitis affects their work and quality of life. According to Zuberbier et al., atopic dermatitis is one of the most common skin diseases worldwide. Vakharia et al. state that 13.8% of patients reported severe or severe pain, and 42.7% reported skin pain within the past week. Twenty-four patients (16.8%) thought that the skin pain was part of the itch, and 16 patients (11.2%) thought it was from scratch. Based on the results, patients report having high skin pain from atopic dermatitis along with experiencing poor sleep, depressive symptoms, and poorer quality of life. From contact dermatitis, Pesonen et al. state that colophonium is a solid resin obtained from coniferous trees, and the main contact allergen. It is common in everyday surroundings, including adhesives of tape, plasters, and dressings. The results conducted by Pesonen et al. state that occupational contact dermatitis is caused by exposure to colophony, and the occupations that are at risk of occupational contact dermatitis from colophony include the wood industry, machinists, and workers involved in agriculture.

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Project Category: Physical Sciences & Engineering

Effects of Cascading Optical Processes on Spectroscopic Measurements for Optically Dense Fluorescent Samples

Optically dense (OD) materials are abundant in nature and often appear as analytical samples. Therefore, reliable quantification methods are essential to determine the quality and composition of OD materials. However, the currently available methods for obtaining spectroscopic measurements for OD fluorescent materials are only accurate at lower concentrations. To remedy this issue, methods such as using smaller sampling volumes and dilution are still used extensively which can alter the optical properties of the OD material being measured. The present work attempted to explore the reasons for the nonlinearity and spectral distortions in spectroscopic measurements of OD fluorescent materials and the contributions of cascading optical processes upon them. To systematically study the effect of optical density and cascading effects on spectral measurements, UV-vis, Fluorescence, and Linearly Polarized Resonance Synchronous spectroscopy measurements were obtained for anthracene and fluorescent polystyrene nanoparticles. The previously derived inner filter effect correction models failed for these samples when the extinction values were greater than 2, providing evidence for multi-step re-absorption and re-emission processes. This work provides new insights into the spectroscopic measurements of OD fluorescent materials which can be utilized in future works for improved spectral analysis.

74
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Project Category: Biological Sciences & Engineering

SELENOH increases the expression of three selenoproteins in the brains of aged mice.

Obtained through the diet, selenium is metabolized mainly in the liver through an intricate process to form the 21st amino acid selenocysteine. When a protein incorporates a selenocysteine residue, the protein becomes a selenoprotein. Selenoproteins have been implicated in diverse physiological and cellular functions, follow a hierarchical distribution within the body, and are more concentrated in certain tissues than others. This study focuses on the expression of five (5) selenoproteins in the brain of male wild-type (*Selenoh+/+*), Selenoh heterozygous knockout (*Selenoh+/-*), and *Selenoh* homozygous knockout (*Selenoh-/-*) mice aged 9 and 18 months. Western blotting analysis was performed to determine how SELENOH deficiency impacts the expression of brain selenoprotein P (SELENOP), selenoprotein W (SELENOW), thioredoxin reductase 1 (TXNRD1), thioredoxin reductase 2 (TXNRD2), and glutathione reductase 1 (GPX1) using the mice (n = 6) aged 9 and 18 months. Results showed that, in comparison with Selenoh+/+ mice, there is an age-dependent decrease in protein expression of GPX1, SELENOP, and TXNRD1 in *Selenoh+/-* and *Selenoh-/-* mice aged 18 but not 9 months. Altogether, *Selenoh* genotype is required to sustain the expression of three selenoproteins (GPX1, SELENOP, and TXRND1) in the brain of mice at old age.

97
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Project Category: Social Sciences

The Role of Mindful Awareness in Hoarding Stigma and Stigma-related Inflexibility

Mental health stigma is a powerful social process known to have harmful effects. It is associated with a range of negative outcomes such as less treatment seeking and lower self-esteem (Corrigan et al., 2014). Hoarding disorder is one of many stigmatized mental disorders. While little research has been done on hoarding stigma, previous research suggests that psychological inflexibility, perspective-taking, and empathy are related to stigma more generally (Krafft et al., 2017; Powell, 2013). This study examined the potential interaction between two components of psychological inflexibility, mindful awareness and cognitive fusion, and the potential interaction of each component with perspective-taking and empathic concern, in predicting hoarding stigma and stigma-related inflexibility. 354 college students participated through an online survey by completing multiple self-report measures at baseline and at 4-week follow-up. Each potential interaction was investigated in a separate multiple linear regression analysis. Missing data was accounted for using multiple imputation. Results indicated a significant interaction between mindful awareness and cognitive fusion in predicting stigma-related inflexibility (b=0.22, SE=0.06, p<.001). In addition, there was a significant interaction between mindful awareness and perspective-taking in predicting two aspects of hoarding stigma, difference, which refers to perceiving people with hoarding disorder as different from others (b=0.06, SE=0.02, p<.001) and blame, which refers to blaming people with hoarding disorder for their condition (b=0.05, SE=0.02, p=.02). There was also a significant interaction between mindful awareness and empathic concern in predicting difference (b=0.04, SE=0.02, p=.04). These findings suggest that mindful awareness may play an important moderating role in relation to hoarding stigma. Results show low mindful awareness is related to higher stigma when combined with low cognitive fusion, low perspective-taking, and low empathic concern. This provides insight into how the interaction of these stigma-related processes impact stigmatizing attitudes towards people with hoarding disorder.

28
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Project Category: Physical Sciences & Engineering

Alloying the Chalcogenide Perovskite Barium Zirconium Sulfide with Titanium as Colloidal Nanomaterials

Over the past several years, the enthusiasm surrounding the chalcogenide perovskite, BaZrS3, has grown significantly due to its promising optoelectronic potential to reconstruct the current composition of solar cells. Unlike lead halide perovskites, which are made up of toxic material and have poor stability, BaZrs3 has the potential to have excellent stability and performance. The bandgap for BaZrS3 is measured at 1.8 sceV, which is higher than the ideal bandgap of single junction and silicon tandem solar cells. To lower the bandgap, the chalcogenide perovskite was alloyed with a titanium precursor as colloidal nanomaterials at varying concentrations, times, and temperatures. In addition to a decrease in the lattice parameter, the XRD pattern shows a transition from the orthorhombic to the hexagonal phases as the concentration of titanium is increased, which suggests the successful incorporation of the dopant.

98
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The Effects of Physical Activity Intensity on Stress Levels in College Students

College students face significant stress during the late puberty and early adulthood stages, which can have detrimental effects on their well-being. This study aims to investigate the impact of physical activity on stress reduction among college students, focusing on the intensity of activity and potential gender differences. The prevalence and consequences of stress among college students are discussed, highlighting the need for effective treatment strategies and preventive measures. The study will employ a conceptual framework that integrates theories of stress, physical activity, and gender differences. By examining how various intensities of physical activity affect stress levels in college students, this research aims to provide insights into the most effective forms of activity for stress reduction. Additionally, the study will explore whether gender moderates the relationship between physical activity and stress, acknowledging potential differences in stress response and coping mechanisms. The research will adopt a survey design approach to assess stress and physical activity levels. A sample of college students will be recruited, and data will be collected using validated questionnaires. Descriptive and statistical analysis will be conducted to examine the relationship between physical activity intensity and stress levels, while also exploring potential gender differences as a moderator. The findings of this study can contribute to the development of tailored interventions aimed at reducing stress among college students. Understanding the impact of physical activity, including the intensity and potential gender differences, can guide educators, parents, and mental health professionals in implementing effective preventive measures and treatment strategies. Ultimately, this research strives to enhance the well-being and academic success of college students by providing evidence-based recommendations for stress management through physical activity.

99
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Study of the Relationship Between Socioeconomic Disparities and Cancer
Across the United States, cancer is a disease that takes the lives of many people each year. It happens to many people with different socioeconomic status, however, the most common denominator in these patients is that they come from low-income communities. Furthermore, minorities had lower survival rates when diagnosed. African American people also were at a higher risk for contracting bladder cancer. This study is expected to improve the healthcare of these population groups.

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Project Category: Biological Sciences & Engineering

Development of Methods for Surface Analysis of Additively Manufactured, Hydroxyapatite Coated Magnesium Scaffolds

Bone implants typically consist of metals such as titanium, cobalt-chromium, or stainless steel due to their mechanical strength. However, the strength of these materials exceeds that of bone which can lead to stress shielding, atrophy of bone, and/or pain, requiring revision surgeries. As research progresses, biodegradable implants may alleviate these issues. As a biodegradable metal, magnesium promotes osteogenesis but can degrade too fast causing gas pockets and/or insufficient mechanical strength. We hypothesized coating of porous WE43 magnesium alloy with hydroxyapatite would slow degradation compared to non-coated samples. A 20-day degradation study was performed with coated and non-coated samples (n=6). Mass and pH were recorded throughout the study. Only non-coated scaffolds had a reduction in mass (35% by day 20); no change in mass of HA coated scaffolds was observed. Likewise, pH was higher for non-coated scaffolds at days 10 and 20. In addition to these macro-level measures, micro-level measures of the extent of degradation are also needed but are challenging to obtain, particularly on porous samples. Thus, a method was developed to measure line roughness, surface roughness, average step height, maximum height, and minimum height of day 20 samples using a surface profilometer. The average step height, a measure of the difference in height of the degraded sample and the original (non-degraded) sample, indicates that the coated samples degraded slower than the non-coated samples, further supporting our hypothesis. The methods developed in this work are critical for establishing a protocol for surface analyses of porous samples in future degradation studies.

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Project Category: Physical Sciences & Engineering

Simulating New Potential Inhibitors for Human Carbonic Anhydrase II

Abnormal levels and activities of the human carbonic anhydrase II (hCAII) enzyme are involved in diseases such as glaucoma, edema, epilepsy, and altitude sickness. Simulating the possible interactions of different isomers of a novel potential hCAII inhibitor with the side chains of the enzyme's active site may be useful for determining their capacity as hCAII inhibitors. Molecular docking calculations produced three orientations for each of the *ortho*-, *meta*-, and *para*- isomers of the inhibitor. For each of the isomers, orientations were chosen where the inhibitor was located near the hydrophilic, hydrophobic, or center of the active site, respectively, for a total of nine simulations. The ligands and protein were solvated with water and sodium chloride to simulate the typical environment of the physical experiment, with extra chloride ions added to neutralize the system. The systems were then minimized, heated, and equilibrated before running 200 ns molecular dynamics simulations. The molecular mechanics-generalized Born surface area (MM-GBSA) method was then used to calculate the binding free energy of each inhibitor orientation to hCAII. The *ortho*- isomer had the highest binding free energy. The conformations where the ligand was located near the hydrophilic section of the active site generally were the most stable. These results help us understand on a molecular level the results of related experiments.

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Project Category: Biological Sciences & Engineering

Assessment of drought and non-stress bean crops using high-throughput (HTP) phenotyping and agronomic data

Drought stress can pose serious threats to bean crops, such as yield reduction or plant mortality. The experimental groups of bean plants in this study were subjected to drought (DR) and non-stress (NS) conditions to investigate the environmental impact on the target correlations. This study aims to explore the correlation between key agronomic variables and bean plant yield through rigorous statistical analysis of high-throughput (HTP) data. Data collection involved multiple methods, including the use of a proximal sensing cart, drone, and manual measurements, to facilitate comparison and cross-verification in 2017 and 2018 in Puerto Rico. The proximal sensing cart utilized Crop Circle ACS-470 multi-spectral crop canopy sensors for measuring canopy reflectance, MB7364 HRXL-MaxSonar®-WRS ultrasonic sensors for canopy height, and Apogee SI-111 infrared thermometers for canopy temperature. High-precision RTK-GPS coordinates were obtained using an A325™ GNSS Smart Antenna and multiple base stations in the field. Geospatial data processing was conducted using the open-source Quantum Geographic Information System (QGIS) software, enabling the translation of coordinates, accounting for the cart's direction of travel, defining plot polygons while excluding edge effects, calculating mean values within each polygon for each sensor, and assigning plot numbers to the data points. Data was then merged and organized into dataframes suitable for Python libraries, such as Pandas, to handle. For the statistical analysis, a mixed linear model and various machine learning (ML) models will be employed to analyze the curated data. Additionally, artificial intelligence (AI) techniques will be employed to extract valuable insights from the datasets and identify potential associations among sensor data, disease response, phenology, and yield. This analysis will contribute to a deeper understanding of bean crop responses to DR and NS conditions and provide insights for the development of precision agriculture strategies. By meticulously curating and analyzing HTP data, this study will uncover associations between agronomic and phenotypic variables.

30
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Faculty Advisor: Jason Street, Sustainable Bioproducts
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Funding: NSF REU: REU INFEWS
Project Category: Physical Sciences & Engineering

Novel sonication methodology to improve methylene blue adsorption on biochar: kinetic and equilibrium studies.

Harmful dyes and contaminants pose significant environmental challenges. Activated carbons have proven useful in adsorbing these substances due to their high porosity and large internal surface areas. To enhance the adsorption capacity of biochar for methylene blue, we employed sonication with the addition of air, a process involving the application of sound energy to activate and increase the surface area of the biochar. Various solvents and temperatures activated the biochar and increased methylene blue dye adsorption. Experiments were conducted to analyze methylene blue dye's adsorption equilibrium and kinetics at temperature (20 °C). Our findings showed that the adsorption capacity of activated carbon increases with higher temperatures and more intense solvent conditions. This suggests that the greater activation intensity correlates with enhanced adsorption capability. This research provides valuable insight into effectively removing harmful dyes and contaminants from the environment using activated carbon-based materials.

77
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Funding: USDA ARS Biophotonics
Project Category: Biological Sciences & Engineering

Bioelectrical impedance analysis proves to be a useful tool for determining body composition in pre-weaning beef calves.

Recent findings indicate seminal plasma primes the uterus for pregnancy, assisting in embryo implantation and growth. Previous findings show decreased conceptus size in seminal plasma primed cows. Thus, the objectives of this study were to determine the effects of seminal plasma uterine priming on postnatal body composition and evaluate the effectiveness of bioelectrical impedance analysis (BIA) in determining body composition in pre-weaned beef calves. Control (n = 9) and seminal plasma primed (n = 7) calves underwent BIA, carcass ultrasonography, and body condition scoring at 210 ± 10 days of age. Resistance, reactance, phase angle, body weight (BW), and temperature collected by BIA were used to calculate fat free mass (FFM), fat free soft tissue (FFST), sum of leg, sirloin, rack, shoulder, neck, riblets, shank, and lean trim (SUM), sum of leg, sirloin, loin, rack, and shoulder (LSLRS), sum of leg, sirloin, and loin (LSL), protein, fat, moisture, and lean. There were no differences in body composition measures among treatment groups ($P > 0.05$). Fat free mass was positively correlated ($P \leq 0.05$) with ribeye area, rib fat, body weight, FFST, SUM, LSLRS, and LSL. Conversely, FFM was negatively correlated ($P \leq 0.05$) with moisture, protein, fat, and lean. Ribeye area was positively correlated ($P \leq 0.05$) with SUM by BW and LSL by BW but negatively correlated ($P \leq 0.05$) with moisture by BW, protein by BW, fat by BW, and lean by BW. Rib fat was positively correlated ($P \leq 0.05$) with LSL by BW but negatively correlated ($P \leq 0.05$) with moisture by BW, protein by BW, and lean by BW. Overall, seminal plasma uterine priming did not impact postnatal body composition, however, BIA was shown to be an effective measure of body composition when compared with carcass ultrasonography.

31
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Funding: NSF REU: CCS
Project Category: Physical Sciences & Engineering

Title: Advanced time integrators for reaction-diffusion systems in pattern formation

Partial differential equations play a crucial role in our fundamental understanding of physical laws which govern the world around us. This project focuses on the study of the reaction-diffusion equation proposed by Alan Turing, which serves as a prototype model for pattern formation, commonly known as the Turing pattern. Specifically, the Turning model has been widely used to explain how spatial patterns form autonomously in an organism, such as spots, spirals, and stripes. In our work, we consider the Gray-Scott model using Gaussian pulses as initial conditions. Since this is a nonlinear model, it is typically impossible to solve it analytically. Thus, numerical methods were employed for finding approximation solutions. For spatial discretization, we utilized finite difference methods, while for temporal discretization, we proposed an advanced time integrator based on exponential methods. Using this, we performed numerical simulations on the model and compared our method with three popular temporal-discretization methods: (1) the Forward Euler method (2) the Crank-Nicolson method, and (3) the Runge--Kutta 4th order method. These include comparisons in terms of accuracy, i.e., convergence rates, and efficiency, i.e., computational times. Our results confirm the effectiveness of the proposed method as well as reveal the fact that different choices of parameters in the model lead to diverse patterns, involving stripes, spots and transitions between them.

78
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Funding: NIAID Research Education Program (R25)
Project Category: Biological Sciences & Engineering

Optimizing Biofilm Production Procedure *in vitro* using *M. haemolytica* and *P. multocida*

M. haemolytica and *P. multocida* are both primary bacteria that contribute to cattle bovine respiratory disease (BRD), resulting in millions of dollars of loss yearly for the feedlot industry. These pathogens are commensal and have adapted to be able to survive and spread on respiratory mucosal surfaces by evading cattle host immune responses and by forming biofilms. Biofilms are communities of bacteria that grow on and adhere to the surface of a structure. There is evidence to support that these microbes are developing antibiotic resistance in-vivo. *Mannheimia haemolytica* and *Pasteurella multocida* were the bacteria used as single-colony cultures to be used and cultures were diluted 1:10 in BHI and used for biofilm formation. Three different matrices were used – Collagen, Fibrinogen, and Chondroitin Sulfate. These were used separately and in conjunction with each other to observe how well the biofilm adhered to the culture plate. The preliminary results suggest that Collagen is a better matrix for biofilm formation, followed by chondroitin sulfate. Lastly, fibrinogen did not help biofilm formation, leaving the same unstained 12-well plates consistent with the Fibrinogen results. Further research to optimize biofilm formation will combine these matrices, and explore the impact of time on biofilm formation.

103
Name: Phillips, Anne Louise
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Funding: Shackouls Honors College Research Fellowship
Project Category: Humanities & Arts

Star Wars as a Modern Mythology
Why has the Star Wars franchise been so resonant in each generation since its conception, and why are some aspects of the franchise more timeless than others? It is clear that the franchise has maintained cultural reach and relevance, but it is also evident that some installations have been much less successful and timeless than others. CGI, the introduction of midi-chlorians, and the growing wealth of lore related to the fictional universe have all been praised and blamed in turn, but the fact remains that the series is firmly established as a modern mythology. Through analysis of the classical and archetypal roots of the Star Wars films, I will argue that the original Star Wars trilogy, by speaking more to myths and archetypes, has remained more timeless than the prequel films, which moved from mythology more into the realm of science fiction; and that recent Star Wars projects have worked to bridge this gap and expand the mythological aspect of the franchise.

79
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Funding: NIH R25 SRE
Project Category: Biological Sciences & Engineering

Optimizing a Protocol for Metabolite Extraction from Mouse Liver Tissue for NMR Analysis

Selenium, despite its low daily intake requirement, is essential to maintaining homeostasis as it is a critical component of selenoproteins. Studies conducted by Dr. Wen-Hsing Cheng have demonstrated that selenium deficiency can induce glucose intolerance and insulin resistance in mice. However, the full scope of the impact of selenium levels on metabolic processes is not yet understood. Therefore, a study was conducted to optimize metabolite extraction protocols and pulse program sequence for analysis on the Nuclear Magnetic Resonance (NMR) spectroscopy platform, so that the resultant protocol can be used in conjunction with Dr. Cheng's experiment. Due to the limited supply of mouse tissue samples, this preliminary study is critical to ensure successful spectral data acquisition. The metabolic data obtained from the mouse livers will be used to assess the relationship between selenium levels and various metabolic pathways that are implicated in glucose regulation. Four protocols for metabolite extraction for analysis on the NMR platform were selected from literature. Extraction protocols were selected by considering two factors: diversity of extraction methodology and similarity in tissue sample weight required. Mouse liver samples were obtained from Dr. Cheng's lab and were homogenized using liquid nitrogen. After homogenization, samples were pooled and divided into aliquots for each protocol. The selected protocols were performed, and the extractants were analyzed using a 500 MHz NMR machine. The results of this study are discussed in the poster.

104
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Major: English - Bachelor of Arts
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Project Category: Humanities & Arts

Beyond "His Native Town": Travel and Alienation in Mary Shelley's *Frankenstein*

Mary Shelley's 1818 novel *Frankenstein* features a surprisingly extensive variety of locations through which Victor Frankenstein travels, ranging from the vibrant cities of London and Oxford to the isolated Orkney Islands and Arctic lands. While some scholars have analyzed the roles which some of these settings, namely, the Alps and Arctic, play in the novel, and several have noted the importance of travel to the text, little scholarship exists assessing the function of Victor's travels as a whole, how they impact him, and what they do for the story. Given the prominence of travel in Shelley's text, as well as the fact that travel is an important theme of Romantic literature in general, this paper seeks to provide an explanation for the function of travel in *Frankenstein* by examining the full range of the novel's settings and their effects on Victor. Specifically, by looking at travel, as several literary scholars have described it, as a process of "self-discovery," I argue that Victor's travels serve to reveal, to himself and to readers, his alienation from humanity and nature. Not only does he find himself in increasingly isolated locations over the course of his journeys, but his experiences in the settings themselves reveal various ways in which he is isolated. He discovers his alienation from humanity by traveling to urban spaces, in which he recognizes his failure to have sympathy with the masses of society and to live up to the ideals of human behavior. Meanwhile, he discovers his alienation from nature by traveling through wilderness spaces, which Shelley continually portrays as in opposition to him. Thus, Victor's traveling is the means by which Shelley communicates his complete separation from the world which ultimately results from his aberrant application of scientific study in the formation of the sentient Creature.

32
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Funding: NSF REU: CCS
Project Category: Physical Sciences & Engineering

Madelung Potential and Charge Transfer Energy for Electron and Hole-Doped High-Tc Cuprate Superconductors.

Unconventional Superconductivity has notably been characterized by the unusually high critical temperatures (Tc) and the lack of adherence to the standard Bardeen-Cooper-Schrieffer (BCS) theory in which the Cooper pairing between electrons is mediated by lattice vibrations called phonons. For high-Tc cuprates, electronic pairing takes place within the CuO_2 layers when materials are doped with holes or electrons; but, the mechanism of pairing is not understood despite three decades of research. A key parameter in models of CuO_2 planes is the Charge Transfer Energy Δdp which measures the difference in single-particle energies for holes on oxygen *p* versus copper *d* orbitals. For undoped insulating parent models, Δdp is positive and one *d* hole is present on each copper atom making its ionic charge 2+. While most theories on cuprate superconductivity take Δdp to be a constant, newer theory has proposed a copper valence transition (S. Mazumdar, Phys. Rev. B 98, 205153 (2018)) such that Δdp would become negative. Determining Δdp in doped cuprates is a difficult multi-body problem that lacks a classical approach; however, the largest contribution to Δdp is the electrostatic Madelung energy. This was calculated for two different Cuprates using GULP (the General Utility Lattice Program). With algorithm manipulation to uniquely generate electron and hole-doped models, data aggregated from electron-doping shows an inversely linear trend where, as the system experiences a greater doping percentage, Δdp decreases. This correlation holds when applying 5% and 10% pressure – adjusting the c-axis in 0.1 increments – though at a net higher Δdp value than the trend at 0% pressure. This inverse correlation between Δdp and doping percentage shows that a valence transition becomes more likely with doping.

80

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Funding: CFR Sustainable Bioproducts USDA REEU program
Project Category: Biological Sciences & Engineering

Initiation of exposure test of coated wood flooring panels

Wood panels used for flooring must be coated to protect them from exposure to the elements, as wood is a porous material that can absorb moisture, leading to swelling, warping, and eventual decay. Coatings create a protective barrier that prevents water from penetrating the wood and causing damage. Additionally, coatings provide resistance against scratches, stains, and UV radiation, which can fade the natural color of the wood and compromise its structural integrity over time. By applying a protective coating, wood panels are safeguarded against the detrimental effects of moisture, sunlight, and wear, ensuring longevity and aesthetic appeal.

In this experiment, we conducted an exposure test on wood panels treated with selected coatings to investigate their response to environmental elements, including sunlight, rain, temperature, and humidity. The objective was to assess changes in the properties of the wood panels, specifically color, glossiness, dimensions, and mass, over time. Prior to exposure, measurements were taken using a spectrophotometer to quantify color changes, a gloss meter to assess glossiness, a vernier caliper to record dimensions, and an analytical balance to determine mass. These measurements were repeated at 1-week intervals to monitor and evaluate the effects of exposure on the wood panels. The results will provide valuable insights into the performance and durability of different coatings under environmental stressors, aiding in the development of enhanced protective treatments for wood materials.

33
Name: Richardson, Richard
Major: Physics - Bachelor of Science
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Faculty Advisor: Amanda Diegel, Mathematics
Funding: NSF REU: CCS REU
Project Category: Physical Sciences & Engineering

Numerical Verification and Simulation of a Two-Phase Fluid Flow Process

We present here results from a numerical method that simulates two-phase flow via the Cahn-Hilliard-Navier-Stokes (CHNS) system of equations. The CHNS system of equations couples together two important but computationally difficult equations: the Cahn-Hilliard (CH) equation and the Navier-Stokes (NS) equation. The role of the CH equation is to track phase separation under the assumption that neither of the two components of the fluid make-up dissipates. The role of the NS equation is to capture fluid dynamics such as fluid velocity and pressure. The numerical method relies on the finite element method for spacial discretization and the finite difference method for temporal discretization.

81
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Major: Biochemistry - Bachelor of Science
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Funding: College of Agriculture and Life Sciences URSP
Project Category: Biological Sciences & Engineering

Functional role of SELENOH in the skeletal muscles of aged mice

As a micronutrient, Selenium aids in various critical cellular and organismal activities and its deficiency has been identified as a risk factor for age-related diseases like type 2 diabetes. Insulin resistance, a hallmark of type 2 diabetes, is a pathological condition caused by the failure of insulin-dependent cells, such as skeletal muscle and liver, to respond properly to normal insulin levels in the bloodstream.

In this study, we determine the impact of SELENOH deficiency on the expression of two (2) low-hierarchy selenoproteins; glutathione peroxidase 1 (GPX1) and selenoprotein W (SELENOW), in the skeletal muscle of male wildtype (Selenoh+/+), Selenoh heterozygous knockout (Selenoh+/-), and Selenoh homozygous knockout (Selenoh-/-) mice aged 9 and 18 months. Skeletal muscle thymoma viral proto-oncogene (AKT) phosphorylation on Threonine 308 and Serine 473 was used as a marker of insulin sensitivity. Our results showed that SELENOH knockout caused a significant decrease in the expression of GPX1 and SELENOW, in aged mice. Overall, these results suggest a functional role of SELENOH in the skeletal muscle of aged mice. Updated results will be presented in the symposium.

34
Name: Roberts, Benjamin
Major: Chemical Engineering - Bachelor of Science
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Project Category: Physical Sciences & Engineering

NMR Study of Methenamine Hydrolysis

As the world's carbon dioxide footprint has become more apparent, subsurface storage of CO2 has been explored as a solution. An issue that might compromise this solution is the leakage of CO2 back to the surface. In order to prevent CO2 leakage, CO2-sensitive chemicals may be injected into the leak-prone areas of the subsurface reservoirs. These compounds convert from liquid into gel or solid when they encounter CO2, and subsequently block the leakage pathway. One such CO2-sensitive chemical, that is the subject of this study, is composed of methenamine, resorcinol, and polyacrylamide. Methenamine, which has applications in pharmaceuticals and resin production as well, is key in triggering the gelation process. It is believed that the aqueous solution of methenamine hydrolyzes into formaldehyde under the acidic condition induced by CO2. However, information on the kinetics of methenamine hydrolysis and its products is limited. Here we study the kinetics of methenamine hydrolysis into formaldehyde and identify the other products of this reaction through NMR spectroscopy. Our results demonstrate how formaldehyde is produced as a result of methenamine hydrolysis under different acidities and temperatures. These findings will assist with the optimization of CO2-induced gelation and understanding the mechanism of methenamine-based drugs for bacterial infections.

35
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Funding: NSF REU: Computational Methods with Applications in Materials Science
Project Category: Physical Sciences & Engineering

Adaptive Diffusion in Partial Differential Equation Denoising Methods

Any picture taken has elements of noise weather that be from the camera lens, transferring data, or dust in the air. We work with minimizing functionals and the associated Partial Differential Equations to reduce the amount of noise in an image without blurring edges between objects in the image. We accomplish this by constructing algorithms in MATLAB which is a coding platform that does well with large matrices. The multiple algorithms we explored are the generalized improved total variation, a model developed by Karl Krissian at Harvard medical school, and the Non-Standard Anisotropic Diffusion (NSAD) model. In this project, we develop a new denoising method by normalizing the coefficient of the diffusion term in the NSAD model. We also consider variational coefficients in the fidelity term of conventional PDE based techniques. The goal of these new developments is to adaptively apply amounts of diffusion for more accurate denoising. We use the Peak Signal to Noise Ratio (PSNR) to compare our processed image to a clean version. This measurement yields quantitatively how well our algorithm works. The denoising models are implemented and tested iteratively until the image becomes blurry or reaches the highest PSNR.

36
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Co-Author(s): Sean Stokes
Funding: NSF REU: INFEWS
Project Category: Physical Sciences & Engineering

Probing the Solvent Compatibility of human Carbonic Anhydrase II - A robust biological platform for hybrid catalyst development

Hybrid catalysts combine traditional catalytic compounds with biomolecules, creating a new platform for selective transformations. Biomolecules, such as proteins and DNA, offer steric hindrance and chiral environments that enable the development of novel and selective reactivity towards a wide range of substrates. However, a challenge in developing these hybrid catalysts stems from the fact that biomolecules are easily soluble and stable in water. The solubility and stability of biomolecules in mixed solvent systems, which provide a broader reaction landscape for catalyst development, are not well-understood. In this study, we aim to address this issue by investigating the stability of human carbonic anhydrase II (hCAII) in mixed aqueous solvent systems. To accomplish this, we employed a variety of biophysical techniques, including circular dichroism (CD), fluorescence spectroscopy, UV-VIS spectroscopy, and differential scanning calorimetry (DSC), to assess the structural and thermodynamic stability of this protein in different solvents. By gaining a better understanding of these properties, we can enable the future utilization of hybrid catalysis systems in various media and conditions.

82
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Funding: R25 Program
Project Category: Biological Sciences & Engineering

Exploring the Impact of Hydroxyapatite (HA) Ratio in the Mechanical Response of PLGA-HA Composite Scaffolds

Trauma, tumor, and infection can result in bony abnormalities. As an alternative to autograft tissue, bioengineered scaffolds are a useful means of treating these problems. The creation of scaffolds that can encourage cell growth and tissue formation has resulted in important developments in the fields of tissue engineering and regenerative medicine. As scaffold materials, poly (lactic-co-glycolic acid) (PLGA) is biocompatible, and hydroxyapatite (HA) is osteoconductive. Compared to polymer alone, HA added into the PLGA matrix has been shown to increase the surface area available for cellular adhesion, proliferation, and differentiation. Scaffold properties can be tailored by adding HA at various ratios, customizing the scaffold to suit tissue engineering applications. This study explores the impact of various HA ratios in PLGA-HA composite scaffolds and how they might improve the mechanical strength of the scaffold. While inadequate HA may hinder the desired cellular responses, excessive HA incorporation may result in compromised mechanical stability, either of which could limit scaffold functionality. Using finite element modeling, our objective was to understand the effects of HA composition on scaffold stiffness by simulating compressive loading of PLGA and HA composites with various percentages of HA (0, 5, 20, and 50%). By offering osteoconductive qualities and enhancement of mechanical strength, the incorporation of HA into PLGA composite scaffolds could show significant promise for bone tissue engineering, enabling the creation of customized scaffolds with improved biological and mechanical performance.

83
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Funding: Shackouls Honors College Research Fellowship, NSF REU: NSF DEB-1916632.
Project Category: Biological Sciences & Engineering

P-LDH/BC as a slow-release fertilizer: Effects on plant growth and the soil microbiome.

Layered Double Hydroxide (LDH) has been recently established as an effective means to remedy nutrient-polluted water. As an efficient low-cost alternative to established remediation methods that is easy to produce and scale, its application as a water treatment relies on the potential for nutrient pollution to be recycled as a slow-release fertilizer. In this project, Mg-Al LDH was synthesized, dispersed on biochar, and adsorbed with phosphorous to obtain a P-LDH/BC complex. The P-LDH/BC complex was characterized for chemical properties including stability, surface area, and available nutrient content. The P-LDH/BC complex was studied for its efficiency as a slow-release fertilizer in green beans (Phaseolus vulgaris) and compared to standard industry fertilizer in a greenhouse experimental study. Based on preliminary analysis, the synergy of biochar and LDH resulted in an improvement in the key growth indicators in green beans compared to standard fertilizer, including yield, nutrient content, height, dry weight, and chlorophyll index. Furthermore, the effects of the P-LDH/BC complex on the rhizosphere and nodule microbiome was studied using molecular DNA extraction methods and related to the key growth indicators. The P-LDH/BC complex is predicted to show an improved microbial activity in the rhizosphere and contribute to an improved soil microbial health in comparison to standard industry fertilizer.

84
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Funding: NIH R25
Project Category: Biological Sciences & Engineering

Investigations on the modulatory role of adipokinetic hormone on the myotoxic effect of honey bee venom using organ cultures of *Drosophila melanogaster*

Hymenoptera venoms are complex mixtures that contain various organic molecules, proteins, peptides, and bioactive elements. These compounds have been identified and their structures determined using biochemical techniques. The venoms of bees, particularly those from the Apis genus, as well as social wasps and ants, have been extensively studied. Honey bee (*Apis mellifera*) venom, in particular, contains the primary peptide compounds melittin, a lytic peptide, apamin, which is neurotoxic, and mastocyte degranulating peptide (MCD). The venom is a non-specific aqua cocktail of substances that causes toxic damage to tissue (effective across different species), leading to localized pain, inflammation, itching, and irritation. Besides it's toxicity, it can elicit an allergic or anaphylactic life-threatening response in mammals. The insect adipokinetic hormone (AKH), analogous to mammalian glucagon has been known to play pleiotropic roles including amelioration/ modulation of effects of toxins. In this study, the modulatory effect of DromeAKH on A. mellifera venom was studied in thorax (muscle) organ cultures of *Drosophila melanogaster.* Thorax was isolated and cultured for 24 h with treatments of venom alone; AKH alone or co-application of venom + AKH. Parallel untreated controls were run and resulting cell viability was assayed using Alamar Blue. Expression of genes involved in inflammatory responses following treatment was also studied using quantitative real time PCR. Results indicated a modulatory role of adipokinetic hormone in the myotoxic effects of the venom on muscle cells.

100
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Funding: Mississippi Rural Physicians Scholarship Program
Project Category: Social Sciences

Community Needs Assessment and the Impact of Rurality on Healthcare: Hurley, MS

Hurley, Mississippi is a small, unincorporated town located in Jackson County. This research was conducted as a part of the Mississippi Rural Physicians Scholarship Program in an effort to raise awareness of the factors that are common in rural areas of Mississippi that impact healthcare and the wellness of residents. According to the Mississippi legislature, a rural community is one with a population of less than 15,000 residents. Throughout the two years that I have been a part of the Mississippi Rural Physicians Scholarship Program, we evaluated a variety of rural areas in Mississippi and the factors that contribute to healthcare disparities in those areas. In Hurley, these factors include educational resources, economic activity, available occupations, and demographics. This research discusses the specific regarding each of these topics in Hurley. Utilizing external databases from the Mississippi State University Extension Center, the United States Center for Disease Control, the Mississippi Department of Health, and other resources, data was gathered relating to the occupations available in and around the area, economic status of the residents, educational resources available in the local school system, and the local demographics. This data was then analyzed by the researcher to find correlations between these factors and the healthcare disparities common to the area and draw conclusions about why this occurs. Upon observing how these factors impact accessibility to healthcare, it is assumed that lower socioeconomic status, higher populations of African American people, lack of funding in education, and jobs that require extensive travel all contribute to the peoples' inability to receive adequate healthcare.

37
Name: Tate, Ruth
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Funding: NIH
Project Category: Physical Sciences & Engineering

Fractal Dimension Analysis in Alzheimer's and Parkinson's Diseases

Brain diseases like Alzheimer's and Parkinson's are neurodegenerative disorders characterized by loss in motor and non-motor functions. Current detection methods for these disorders are only efficient in detecting later stages. Although Alzheimer's (AD) and Parkinson's (PD) begin developing at the nanoscale, symptoms typically become apparent when the disease has progressed. Fractals are structures that exhibit self-similarity at different length scales. Previous work has used this quantification method to detect the various stages of Colon, Breast, Prostate, and Pancreatic cancer. We apply the fractal dimensions to characterize the structural alteration in AD and PD tissues for different stages. We use transmission optical microscopy (BX-61) to acquire images from our biological samples, processed under NIH-licensed software (Image-J) to calculate the fractals. In comparison to previous work, we report that the fractal values for the various stages of AD in comparison to their control increase significantly due to alterations in the mass density distribution. There is a relevant increase in the fractal value for PD when compared to its control.

38
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Funding: NSF REU: Chemical Engineering
Project Category: Physical Sciences & Engineering

Electrospinning of Hybrid Copper-Halide Nanofibers for Photodiodes

Lead-based perovskites offer a variety of optoelectronic applications; however, the toxic nature of lead generates a search for safer alternatives. This study replaces lead with copper metal to lower toxicity while preserving similar optoelectronic properties. Here, we employ organic polymers such as polymethyl methacrylate (PMMA), polyvinylpyrrolidone (PVP), and polyethylene oxide (PEO) as a fiber matrix for encasing Cu-based hybrid halides to attain more stability under extreme environments. Furthermore, these fibers are capable of charge transport when mixed with conjugated polymers, which together with light-emitting Cu-halides can be key components in many optoelectronic devices. By encasing the copper-halide in various additional polymer rubbers, a new capability including stretchability, and flexibility is obtained in addition to their optoelectronic properties. This study seeks to identify a combination of polymers by varying the compositions and loading of each fiber and fiber mat for device applications. Further, their photophysical properties such as Photoluminescence Spectra (PL), UV-Vis Spectroscopy, and Fluorescence Microscopy as well as their mechanical properties such as flexibility, and stretchability will be studied. The combinations of copper-halide nanofibers will produce light-emitting stretchable fibers that will be utilized in various photodiodes and electronic applications.

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Funding: MSU Office of the Provost and Department of Chemistry
Project Category: Biological Sciences & Engineering

Impact of Actin Disruption on Shmoo Formation in Budding Yeast, *Saccharomyces Cerevisiae*

Occidiofungin is an antifungal compound that has demonstrated efficacy against diverse fungal species including human and plant fungal pathogens. Current mechanisms of action indicate that occidiofungin bioactivity is through its targeted disruption of the actin cytoskeleton. In fungi, filamentous actin is required for multiple cellular activities including organelle inheritance, nuclear positioning, and vesicle transport. In Candida species, actin is important for hyphae formation during pathogenic growth and cells exposed to occidiofungin are unable to undergo this switch in cell morphology. In the budding yeast, Saccharomyces cerevisiae, haploid cells can be induced to undergo a change in morphology with the formation of a mating projection following exposure to the appropriate pheromone peptide. Given the role of actin in the formation of this "shmoo" morphology, we aimed to determine whether occidiofungin prevents the formation of a mating projection in wild type yeast. To test this, alpha factor was added to cells in a mid-log culture with and without the addition of a sublethal dose of occidiofungin. Cell were collected at 30-minute intervals over a 2hr period, fixed in formaldehyde and cell morphology analyzed by light microscopy. Initial experimental data indicate that occidiofungin prevents cells from arresting in G1 of the cell cycle with a shmoo-like morphology. These findings suggest that occidiofungin has broad antifungal activity that is effective at targeting fungi at various stages of developmental growth.

101
Name: Toliver, Johntavia
Major: Psychology - Bachelor of Science
Faculty Advisor: Hilary DeShong, Psychology
Co-Author(s): Ben Porter
Project Category: Social Sciences

Investigating comorbidity rates between BPD and PTSD across men and women
Background and Purpose: While women are more likely to seek treatment and thys receive certain diagnoses, like Borderline Personality Disorder (BPD) and Post Traumatic Stress Disorder (PTSD)(Sansone 2011), population studies typically demostrate that rates across sex are more equal (Quian et al. 2022). Given that BPD and PTSD are highly comorbid, investigating potential sex differences in their comorbidity may provide more insight into these disorders. Thus, the purpose of the current study is to compare rates of BPD and PTSD among men and women. **Subjects:** Starkville community members (n=101) completed a study (age range 18-35 [M=21.65; SD=4.05], with 33 men and 68 women in the study at the time of analyses. **Methods and Materials:** Participants completed a structured clinical interview (SCID-5; Powers & Petri et al. 2022) to assess for BPD and PTSD diagnoses. **Analyses:** Descriptive statistics were evaluated within the sample. Then, correlations between PTSD and BPD were assessed for men and women separately. **Results:** PTSD and BPD were correlated in the sample at r=.39 ($p<.001$). When looking just at men, BPD and PTSD were correlated at r=.66 ($p<.001$). For women, PTSD and BPD were correlated at r=.25 (p=.037). **Conclusions:** Overall, the correlation between BPD and PTSD appears to be much stronger for men than women. Thus BPD symptoms may be more strongly linked to traumatic experiences for men than women. This study is limited by its smaller sample size. Thus these analyses should be re-conducted with a larger, more representative sample.

39
Name: Tuck, Kalen
Major: Biological Sciences - Bachelor of Science
University: Tuskegee University
Faculty Advisor: Willard Collier, Chemistry
Funding: NSF REU: Chemistry
Project Category: Physical Sciences & Engineering

Ruthenium(II)-Catalyzed C–H Bond Activation and Functionalization (continuation)

The C–H bond is the most common type of bond in organic compounds. CH bonds are abundant and vital in organic compounds but are considered un-reactive due to their lack of polarity, high bond strength, and low nucleophilicity Transition-metal-catalyzed asymmetric reactions involving inert C–H activation are highly challenging due to the lack of selectivity, substrate -compatibility, catalyst design, among others. A regio- and stereoselective method for hydro arylation of vinyl silanes using a ruthenium (II)-mesitylene complex as the catalyst development. The process involves utilizing in-situ-formed benzaldehyde amine as a transient directing group (TDG) to activate the ortho-C–H bond selectively examining how it is influenced by the ruthenium (II)-arene complex and chiral amine steric interactions. Notably, selectivity towards the branched product has been significantly enhanced, reaching branched-to-linear ratios as high as 15:1 for most studied aldehydes and exceeding 99:1 for specific reactions. The observed stereoselectivity ranges from 66% to 80%ee. Efforts to improve reaction yields and reduce catalyst loading are currently ongoing. Moreover, we are exploring further functionalization and potential applications to alkyl silane products. However, there are still pending tasks, including the investigation of substrate scope, and conducting mechanistic studies on the reactions.

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Name: Turner, Catherine Annalee
Major: Kinesiology - Bachelor of Science
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Co-Author(s): Nathan Conner, Hunter Derby, Jacob Hull, Sally Hatten, Timothy Stewart
Funding: NIOSH/CDC
Project Category: Biological Sciences & Engineering

Efficacy of a novel virtual reality fall prevention training tool on limits of postural stability

Falls are one of the leading causes of both fatal and non-fatal injuries in various populations such as geriatric, clinical, occupational, and even athletic populations. Several fall prevention training programs exist, each with their own limitations. Virtual reality (VR) technology has been constantly evolving and more recently has been used for fall prevention training. The purpose of the study is to test the efficacy of a novel VR fall prevention tool that includes slip-trip perturbations compared to real-world slips and trips on limits of postural stability (LOS). A total of 15 healthy young adults (8 females, 7 males, age 23 ± 3.31) completed two training conditions, real gait training and virtual gait training, which included real and virtual slip and trip hazards, in a counter-balanced order. All participants completed pre-training and post-training assessment of the LOS test on the BTrackS™ platform. Center of pressure (COP) sway area in four different quadrants [anterior left (AL), anterior right (AR), posterior left (PL), and posterior right (PR)] during the LOS test was assessed using a one-way repeated measures ANOVA at an alpha level of 0.05. Significant main effects were found in the PL ($p=0.04$) & AL ($p=0.01$) quadrants along with total score ($p<0.001$). For the PL quadrant, pairwise comparisons revealed significant increases in sway area in post training in the real-world compared to pre-training ($p=0.04$). The AL and total sway showed significantly greater LOS area in post-training in the real-world compared to pre-training, as well as in the post-training in VR condition compared to pre-training. Findings suggest that the VR training tool was equally effective as the real-world training, and significantly improved participant's LOS, which demonstrates a reduced risk for fall and fall-related injuries. Thus, the novel VR fall prevention training tool provides an effective, feasible, low-cost, at-home training for fall prevention.

40
Name: Turo, Ethan
Major: Sustainable Bioproducts - Bachelor of Science
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Co-Author(s): Tom Norman, Yun Sang Kim
Funding: USDA NIFA REEU Program
Project Category: Physical Sciences & Engineering

Optimizing OSB Quality: Assessing the Influence of BCD-EO Treatments

Dimensional instability of oriented strand board (OSB) has long been a persistent issue due to water exposure, weathering, and excessive loads. This creates the need to develop a product that is resistant to water absorption and biological degradation while also having superior strength and internal bond properties. In this study we aimed to assess the dimensional stability and mechanical durability of OSB treated with 1% of four different beta-cyclodextrin essential oil complexes (BCD-EO): eugenol (EUG), trans-cinnamaldehyde (tCN), carvacrol (CARV), and thymol (THY). To fabricate the boards, Southern Yellow Pine (Pinus spp.) wood strands were dried to 6% moisture content and mixed in a drum mixer for 10 minutes with the different BCD-EOs and diphenylmethane diisocyanate (pMDI) adhesive. After mixing, the strands were all oriented in the same direction and pressed in a Dieffenbacher press to produce a 34 by 34-inch board that was 0.46 inches thick. After the boards were cured, they were cut into the size required for the ASTM D1037 internal bond and dimensional stability test as well as the ASTM D3043 bending test. In the internal bond test, the EUG, tCN, and CARV treatments exhibited a decrease in internal bond strength when compared to the control whereas the THY treatment showed a 5% increase. In the bending strength test, all 4 treatment groups had a higher MOE and MOR than the control with the highest percent increase being THY and the lowest percent increase being CARV. In the dimensional stability test, all 4 treatment groups displayed an increase in water absorption and thickness swelling compared to the control after being submerged in water for 24 hours. BCD-EO complexes used in the construction of OSB holds promise; however, further investigations into degradation and biological durability are necessary to fully understand the potential properties of the BCD-EO complexes.

41
Name: Twedt, Tyler
Major: Biochemistry - Bachelor of Science
University: Millsaps College
Faculty Advisor: Wolfgang Kramer, Chemistry and Biochemistry, Millsaps College
Co-Author(s): Margaret Miller, Sharon Suffern, Christopher Bruni, Victor Mishoe, Jacques Kessl
Funding: MS INBRE, funded by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under grant number P20GM103476.
Project Category: Physical Sciences & Engineering

Synthesis of Pyridine-based HIV Integrase Inhibitors

Retroviruses employ three unique enzymes, reverse transcriptase, integrase and protease, that are essential for their life cycle. Antiviral therapy targets those enzymes preferably, as less side effects are expected. Human immunodeficiency virus (HIV), which causes acquired immunodeficiency syndrome (AIDS), is generally combated with triple therapy, consisting of usually two reverse transcriptase inhibitors and one integrase or protease inhibitor. As the high mutation rate of the virus causes resistance, HIV drugs are constantly optimized. HIV integrase incorporates the viral DNA into the host cell genome. HIV Integrase inhibitors are mostly based on aromatic heterocycles such as pyridine and quinoline. In this project, we are constructing the pyridine core by reaction of substituted malonic esters with an aminocrotonate ester. The development of the side chain in the 3-position which consists of a methine carbon carrying a tert-butoxy group and a carboxylic acid, is essential. This requires the extension by one carbon, which we accomplish by a Bode homologation reaction. Here we present our new results in cleaving the Bode compound with various oxidizing agents. Further incorporation of substituents on the pyridine core will determine the efficiency of the inhibitors.

87
Name: Van, Dustin
Major: Computer Science - Bachelor of Science
Faculty Advisor: Souza Martins, Ag & Bio Engineering
Co-Author(s): Colby Reavis, Michele Reba
Funding: College of Agriculture and Life Sciences URSP, USDA Agricultural Research Service
Project Category: Biological Sciences & Engineering

Advancing Sustainable Water Resource Management using Geostationary GOES-R images for Cost-Effective Estimation of Evapotranspiration

Management of irrigation water resources is essential for sustainable agriculture and environmental conservation. One way of optimizing irrigation practices is the measurement of evapotranspiration (ET) which determines plant water usage. However, precise measurement of ET often requires expensive instrumentation, limiting its widespread application. To overcome this challenge, we propose a novel approach utilizing geostationary satellite data from GOES-16, in conjunction with meteorological data, to model ET accurately and cost-effectively. The Normalized Difference Vegetation Index and the Soil Adjusted Vegetation, two necessary inputs for the ET model, are being calculated from processed GOES-16 images from the south region. In addition to these vegetation indices, the DAYMET observations were used to supplement the ET modeling. The findings show that daily composite GOES images for vegetation phenology can form ET calculations. Further improvements can be achieved by validating the model across different geographical regions, climates, and land cover types. Ultimately, the findings of this study contribute to the broader goal of managing irrigation water resources effectively, conserving the environment, and ensuring long-term agricultural sustainability.

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Name: Vordick, Mackenzie
Major: Biochemistry - Bachelor of Science
University: Millsaps College
Faculty Advisor: Wolfgang Kramer, Chemistry and Biochemistry, Millsaps College
Co-Author(s): Zoe Elder, Matthew Lungren, Ian Gould
Funding: MS INBRE, funded by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under grant number P20GM103476.
Project Category: Physical Sciences & Engineering

Quantum Yield of Visible Wavelength Photocleavage of DNA

Photocleavage of DNA has many potential therapeutic and technological applications. In medicine, controlled cleavage of DNA is used in photodynamic cancer therapy. Optimal quantum yields are required for any photochemical reaction, but the quantum yield of DNA photocleavage reactions have not extensively been investigated. Quantum yields are required though to optimize the photon efficiency, but also for mechanistic understanding and reaction optimization. Here we report a novel chemical process for photocleavage of DNA that uses light of visible wavelength. From a cationic precursor the reaction generates an alkoxy radical that initiates cleavage by abstracting a hydrogen atom from the DNA deoxyribose backbone. Quantum yield measurements support the proposed mechanism, identify the energy wasting process and allow optimization of the reaction efficiency.

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Name: Wall, Daniel
Major: Biological Engineering - Bachelor of Science
Faculty Advisor: Xin Zhang, Ag & Bio Engineering
Co-Author(s): Max Feldman, Ruijun Qin, Yanbo Huang
Funding: USDA-ARS Collaborative Projects: ARS Scientist + MSU Scientist + Undergraduate or Graduate Student Intern
Project Category: Biological Sciences & Engineering

Nitrogen status monitoring of potato crops using drone–based multispectral imaging

Researchers have been studying the effects of different fertilizer compositions and fertilization methods on field crop growth, yield, and overall health since the 1900s. While progress has been substantial, potato crops pose a particular challenge due to their unique root make–up and nutritional uptake. In particular, the nitrogen uptake of potato crops has been a heavily studied subject because excessive fertilizer application, containing much nitrogen, can inevitably lead to run–off which may seep into groundwater pools, causing harmful pollution. The worldwide adoption of potato as a hardy, go–to crop exaggerates this phenomenon. This multi–year study is focused on (1) the effects of various nitrogen application amounts (i.e., 0%, 50%, 100%, 150%, and 200% in 2020; 0%, 50%, 100%, 140%, 150%, 200%, 250%, 360%, and 470% in 2021) on potato crop yield and overall health, (2) how different potato varieties (i.e., Norkotah, Alturas, Rainer, and Russet Burbank) respond to those nitrogen applications, (3) and how varying nitrogen application amounts throughout the growing season relates to that of constant amounts, all using drone–based multispectral imaging techniques. Drone–based technologies have emerged, in recent years, as a useful tool for crop monitoring, through regularly scheduled drone flights during the growing season. Five bands of electromagnetic wavelengths were captured in the aerial acquisition: Blue (B), Green (G), and Red (R) of the visible spectrum; Red Edge (RE); and Near–Infrared (NIR). Wavelengths of particular interest are R and NIR. The former was found to be useful in gauging the amount of chlorophyll in crop leaves, which are heavily influenced by nitrogen availability within the plant, while the latter was found to be useful in assessing crop stress. The results from this study will further assess the feasibility of drone–based multispectral imaging for nitrogen monitoring of potato crops.

89
Name: Wallace, Ruth
Major: Poultry Science - Bachelor of Science
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Funding: College of Agriculture and Life Sciences URSP
Project Category: Biological Sciences & Engineering

Effects of Bacillus amyloliquefaciens based probiotic on the production performance of cage-free laying hens

Cage-free laying hens are exposed to pathogens due to prolonged litter exposure. This study aimed to evaluate the effect of a probiotic containing Bacillus amyloliquefaciens on the production parameters of cage-free hens. This experiment used 216 Hy-Line W-36 layers at 36 weeks randomly distributed into 12 cage-free pens (5'X4'). Each pen contained 18 hens and was equipped with a hanging feeder, 3 nipple drinkers, perching facility, nest boxes, and litter was composed of pine wood shavings with an average depth of 3.5 inches. Birds consumed a basal diet to meet the nutritional requirement of breeder guidelines. The treatment diet was supplemented with 1kg of ENVIVA® per ton of feed with the final concentration of 108 CFU of B. amyloliquefaciens per gram of feed. A six-week experiment was conducted. Feed intake, egg production, and egg mass were recorded. This data was used to calculate feed conversion ratio (FCR), then expressed as pound of feed per dozens of eggs, and gram of feed per gram of eggs. Significant reduction of hen-day egg production (HDEP) in birds fed treatment diet compared to the control groups (C: 86.54% vs T: 82.49%; P=0.0216) was found. Egg mass was also numerically higher in treatment group than control group (C: 67.51g vs T: 70.18g; P=0.0624). FCR was numerically better in control group on both feed/dozens of eggs and gram of feed per gram of egg basis (C: 4.143 vs T: 4.305 lb/dozens; P=3499 and C: 2.399 vs T: 2.456 g/g; P=0.0967). Although the feed additive ENVIVA® decreased egg production, this trial was conducted only six weeks. Therefore, it is probable that the hens did not have time to adapt to the feed additive resulting in lower egg production.
Keywords: Feed additive, Feed conversion ratio, Hen-day egg production, Egg mass, Hy-Line W-36

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Name: Weathers, William
Major: Art - Bachelor of Fine Arts
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Project Category: Humanities & Arts

Veins and Arteries
Globally, there exists an engrained system of trade with oil. This expansive relationship with oil brought about “petroculture,” or the new social constructs implemented due to our dependence on petroleum-based goods. After World War II, the international shift in geopolitical power between the Middle East and Europe sparked a newly unified land of people seeking independence. With this power gained through the 1940s and 1950s came an opportunity of oil as an extremely potent form of commercial trade due to the booming demand of oil and the abundance found within what is now some of the Middle East's most prosperous countries such as Iran, Iraq, and Saudi Arabia. In turn this rampant increase in wealth and population has come at the cost of the cultural expungement of local villages and environmental turmoil that oil fields and derricks cause to the landscape. In both the Middle East and Western periphery our common reliance on oil and gas undermines the juxtaposition of perspectives between those who are directly connected to these unstable cities and ruined villages and those who merely complain about rising gas prices or “petroculture” as a spectator. It is with this stage of conflicting conversations that “Veins and Arteries” functions to visually communicate. Appropriating the traditional conventions of maps, this project destroys and reconfigures multiple subjects which span across the seas to connect these polarized perspectives through eccentric materials and visual storytelling. "Veins and Arteries" stands to recontextualize and critically examine the Western perception of "petroculture" with its hidden underbelly of corruption and urbanization to visually engage viewers in a more effective conversation towards a unified solution.

43
Name: Whittington, Justin
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Funding: NSF REU: Optoelectronic Materials
Project Category: Physical Sciences & Engineering

Design and Optimization of High Spin Polymers: Exploring Donor-Acceptor Units for Enhanced Open Shell Properties

Understanding and harnessing the open shell characteristics of high spin polymers have become imperative objectives in the pursuit of next-generation functional materials, with implications ranging from spin-sensitive devices to molecular electronics. The characterization of the polymers necessitated by this drive can be supplemented by a thoughtful analysis of a molecule's electronic properties. Exploring different combinations of notable donors and acceptors provides valuable insight into relationships between molecular structure, what groups are present, and the resulting electronic properties that are indicative of a particularly useful high spin polymer. A wide and various combination of donor and acceptor units are employed to produce diverse molecular architectures, which are geometrically optimized and analyzed using Gaussian 16 software. Here, we are screening out open-shell molecules with density functional theory (DFT) calculation based on their HOMO-LUMO and singlet-triplet gap. Followed by diradical calculation of the desired molecules. Donor-acceptor pairings that prove a higher likely hood of displaying open shell character are further optimized via variations in accessory groups. These variations highlight what minute alterations in a structure may cause large shifts toward pure open shell character. All molecules are screened for open shell character and will be used in the training of a machine learning model. This model will be geared toward discerning patterns and correlations between molecular features and the desired electronic properties.

44
Name: Woo, Chandler
Major: Chemistry - Bachelor of Arts
Faculty Advisor: Sidney Creutz, Chemistry
Co-Author(s): Rajesh Mukkera
Funding: American Chemical Society and Department of Chemistry
Project Category: Physical Sciences & Engineering

The Development of a New "C-H" Transfer Reagent to Access Methylidyne Ligands

The electronic structure and reactivity of iron-carbon multiple bonds remain poorly explored given their importance in facilitating catalytic reactivity involving unsubstituted hydrocarbons. Investigations of these species are currently impeded by the lack of direct synthesis of these complexes. Hence, we have developed a new "CH" transfer reagent to readily access methylidyne ligands for fundamental studies. Anthracene elimination in the reagent acts as a thermodynamic driving force. Furthermore, the pseudo-tetrahedral environment is likely advantageous to accessing these iron-carbon multiple bonds, so complexes featuring this geometry are tested with the reagent. The development of this reagent serves to greatly facilitate investigations on the reactivity of these species as iron-carbon multiple plays an important role in Fischer-Tropsch catalysis and coupling reactions.

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Name: Ziegler, Aniya
Major: Physics - Bachelor of Science
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Faculty Advisor: Ronald Unz, Inst for Clean Energy Technology
Co-Author(s): Matt Wright, Jamie Rickert
Funding: NSF REU: Chemistry INFEWS
Project Category: Physical Sciences & Engineering

The Characterization of Gamma-ray Detector Performance for Remediation Efforts at Nuclear Facilities

The characterization of γ-ray detector performance plays a crucial role in the remediation efforts of nuclear facilities. This study focuses on the collection of validation data for γ-ray detector simulation to ensure accurate and reliable measurements. The data collection procedure developed and approved under an American Society of Mechanical Engineers Nuclear Quality Assurance (ASME-NQA-1) program at the Institute for Clean Energy Technology included calibrations, efficiency determinations, energy resolutions, and background subtractions. The procedure was performed with an Ortec DigiBase Multi-Channel Analyzers mounted to inorganic scintillation detectors, specifically the 3x3 NaI, 3x3 LaBr3, and 3x3 CeBr3 detectors. Calibrations of the γ-ray detectors were performed using standard radioactive sources with known activities and photon energies. The detectors were exposed to these sources, and the resulting spectra were analyzed to establish calibration curves relating the detector response to the energy of the γ-rays. Energy calibration included exposure to these sources, and the resulting emitted photons were analyzed to establish a calibration curve relating the detector response to the energy of the γ-rays. This calibration curve enables accurate energy determination during subsequent measurements. The detection efficiency is calculated by comparing the measured counts to the certified activities. The radiation detector simulation validations are performed by comparing the simulated spectra with experimental measurements using various γ-ray sources. Agreement between the simulated and measured spectra confirms the accuracy and reliability of the simulation. In conclusion, the characterization of γ-ray detectors for use in radioactive material remediation efforts requires a rigorous validation procedure. The described detector characterization procedure provides a comprehensive framework for ensuring accurate and reliable measurement data sets are used for simulation validation.

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OFFICE OF PRESTIGIOUS EXTERNAL SCHOLARSHIPS

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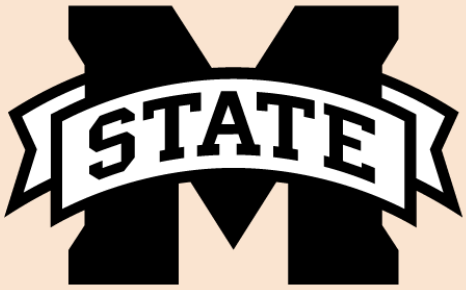
For appointments regarding general scholarship opportunities or preliminary editing of essays, please contact Hanna Clark, Graduate Assistant to the OPES.



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