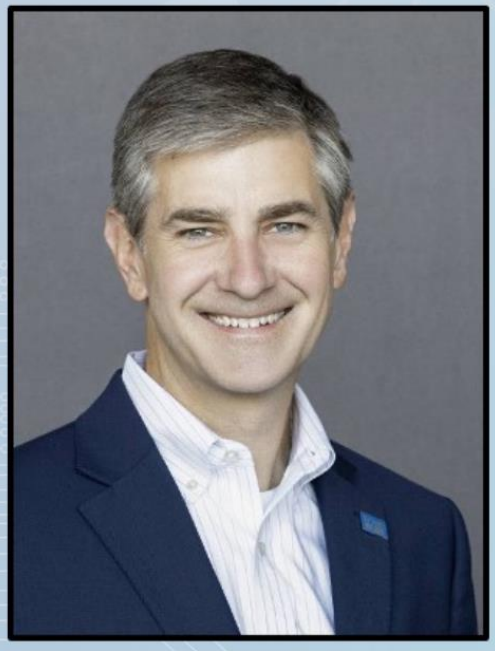
A Celebration of Research & Innovation

CBAS SCHOLARS DAY

March 18, 2025



Welcome to the College of Basic and Applied Sciences Scholars Day. I appreciate your attendance at and support of this important day in the life of our College. Scholars Day is a wonderful opportunity for CBAS faculty and students to showcase their research work and for the entire college community to come together to celebrate the fruits of that labor.

Research is central to the CBAS mission. It is but one way that the College contributes to society, by addressing important problems and generating new knowledge. More importantly, it is vital to the education of our students, as it teaches them to use the scientific method, provides hands-on practice of disciplinary skills, requires them to apply knowledge learned in the classroom, and allows them to experience firsthand the excitement of discovery. Research is never complete until results have been communicated, so Scholars Day itself also represents as important step in the research process.

I am delighted to see continued growth in the event with more than 100 posters entered this year. I am extremely proud of the high quality of research consistently produced in our College. I hope you enjoy these presentations and feel the same sense of pride as you participate in this year's event.

-Greg Van Patten, Dean

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Manager of Workforce Development and Community Relationships at Nissan Motor Corporation

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Abstracts

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Faculty Mentor: Dr. Jeremy Strayer
Mathematics and Science Education - Doctoral

Students' Limit Conceptions and Representational Approaches

Investigating students' thinking about the limit concept in calculus through representational approaches supports the need for students to learn mathematical concepts with deep understanding and actively build new knowledge (NCTM, 2000/2014). This poster presentation shares a portion of the results from a larger study on students' limit conceptions (Intuitive, Informal, and Formal) and their representational approaches (Graphical, Numerical, and Algebraic) to understanding the limit concept. Two research questions to address include:

1. What limit conceptions do students possess?
2. What connections exist between students' limit conceptions and representational approaches?

To address these two research questions, pre-assessment surveys were collected from 63 students enrolled in Calculus II from a public university in the southeastern United States. The surveys have six limit view statements (adapted from Williams, 1991/2001) that constitute the three main classifications of limit conceptions (Intuitive, Informal, Formal) and five multiple/short answer limit problems that constitute the three main representational approaches (Graphical, Numerical, Algebraic). To address research question 1, the analysis involved creating a frequency distribution for the number of times that each of the six limit view statements was selected by students as the most consistent with their understanding of limits. To answer research question 2, we compared students' responses to the six limit view statements to students' choice of representational approaches to the five multiple/short answer problems. We found that the intuitive conception had the most significant frequency, which could suggest that students begin to reason and think about the concept of limits from an intuitive perspective. Also, the results show that students' intuitive limit conceptions are tied to graphical reasoning and informal limit conceptions are connected to numerical reasoning of the limit concept. The results of this study offer both calculus instructors and curriculum reformers ways to integrate students' reasonings and understandings into calculus teaching and learning. Specifically, the results suggest that calculus instructors may leverage on students' limit conceptions and representational approaches to teach the limit concept for a deeper conceptual understanding.

2. Patrick Ahuruonye
Faculty Mentor: Dr. Ngee Sing Chong
Chemistry - Masters

Effects Of Ammonium-Phosphate Based Fire Suppressants on Biomass Combustion Characteristics and Emission Profiles

The escalating impact of climate change on wildfires necessitates innovative fire suppression agents. Analysis of ammonia levels during a recent wildfire revealed concentrations of 1.0-2.1 ppm, significantly elevated from ambient background levels. This study investigates the effectiveness of ammonium phosphate-based fire suppressants in reducing harmful emissions from burning biomass. Emissions from pinecones, twigs, and leaves, both untreated and treated with fire suppressants, were analyzed using Fourier Transform Infrared Spectroscopy (FTIR) and Gas Chromatography-Mass Spectrometry (GC-MS).
The study quantified low molecular weight compounds (CH4, NH3, CO2, etc.) and tentatively identified volatile organic compounds (VOCs) primarily comprising alkenes, aldehydes, and aromatics. Combustion characteristics and VOC concentrations were compared for emissions from biomass treated with different fire retardants. Scanning electron microscopy and energy-dispersive X-ray microanalysis revealed that the nitrogen from the Phos Chek suppressant was mostly lost, while phosphorus remained in the residue. Results demonstrated that fire suppressants significantly reduced harmful emissions from biomass combustion. However, despite this reduction, concentrations of certain toxicants, including carbon monoxide, benzene, and 1,3-butadiene, remained a concern for firefighters. This research elucidates the potential of these suppressants for mitigating inhalation exposure risks, improving wildfire management strategies, and enhancing environmental protection.

3. Elizabeth Aina
Faculty Mentor: Dr. Keying Ding
Chemistry - Masters

Development of a Cobalt Complex Catalyzed Green Approach for Sustainable N-Alkylation of Amines

The N-alkylation of amines is a widely used organic synthesis transformation, particularly in pharmaceutical production. However, conventional methods for amine N-alkylation are often economically and environmentally unsustainable due to their reliance on toxic reagents and precious metals. In this study, a phosphine oxide pincer ligand was synthesized to develop a cobalt-based complex, which serves as a catalyst for the N-alkylation of amines using alcohol substrates with diverse structures. This approach integrates green chemistry principles, enabling efficient alkylation while significantly reducing chemical byproducts. The method offers a promising advancement for sustainable pharmaceutical synthesis.

4. Ian Alcox
Faculty Mentor: Dr. Hanna Terletska
Physics and Astronomy - Undergraduate

Study of Quantum Materials with the MuST Ab Initio Electronic Structure Calculation Package

Through traditional means, the study and fabrication of new materials is often very expensive and time-consuming. With the advent of more powerful computational systems and well refined tools to utilize it, we have been able to develop methods such as Density Functional Theory (DFT) to computationally model and predict the properties of materials. It is the goal of the MuST Project to develop an open-source software that can more accurately handle these systems while accounting for the disorder and complexity present in real-life systems. Through continued the continued study of especially materials sensitive to quantum effect (e.g. semiconductors, superconductors, high entropy alloys), we hope to further refine MuST's ability to handle these materials of such high utility and interest and provide a cheap and easily accessible means to study them at a high volume.

5. Rahmi Aini
Faculty Mentor: Dr. Elizabeth Barnes
Mathematics and Science Education - Doctoral

conVIZ: A New R Package for Analyzing and Visualizing Concept Networks in Biology Education

This project introduces a new innovative R package designed to analyze and visualize concept networks in biology education, and more broadly, in any learning content. Recognizing that traditional assessment methods often only focus on only evaluating whether students can recall elements of in a topic (such as concepts, facts, and principles), it typically not able capture whether students' responses demonstrate meaningful and scientifically accurate connections between these elements. This R package, conVIZ, shifts the focus from merely reporting students' scores or the frequency of correct answers to mapping out the co-occurrence and interrelationships of key concepts that students understand. This approach enables a more holistic evaluation of student performance. The impact of this package extends beyond the classroom. For biology education researchers, it offers a novel method for exploring the cognitive networks that underpin scientific understanding, facilitating more targeted educational research. In practice, instructors can use these insights to design interventions that directly address identified gaps and misconceptions, thereby enhancing the overall learning experience. Ultimately, conVIZ bridges the gap between qualitative insights and quantitative measures, fostering a deeper, more connected understanding of biological concepts that is essential for advancing both science education and student success.

6. Carlos Aldana Lira
Faculty Mentor: Dr. Tasha Frick
Computer Science - Undergraduate

Exploring Students' Conceptions of Variable Assignment in an Introductory Computer Science Course

Computer science education (CSEd) researchers have accumulated a rich body of literature describing the misconceptions students develop when learning to program. While these descriptions have helped instructors anticipate students' difficulties, an exclusive focus on misconceptions has created a deficit model of student knowledge and drawn resources away from developing models of students' knowledge suitable for design research. To better understand students' knowledge, I conducted think-aloud interviews with 6 students in the first four weeks of a fall semester. Through a qualitative analysis of interview recordings, transcripts, and students' problem solutions, I identified four distinct conceptual resources that highlight the importance of students' prior knowledge in programming contexts. The resources include: (1) assignment as equality, represented by students interpreting the assignment operator as the mathematical equals sign; (2) assignment as change, represented by students interpreting the assignment operator as modifying variables' values; (3) assignment as transitive, represented by students interpreting the assignment operator as linking variables' values; and (4) identifier as value, represented by students replacing variables with their values when interpreting code. Students' use of these resources varied within and across interview task, highlighting the dynamic, context-sensitive nature of student knowledge. These findings provide guidance for instructors to build on students' existing ways of thinking and answer prior calls to develop domain-specific theories of CS knowledge suitable for design research.

7. Julia Barnett
Faculty Mentor: Dr. Cole Easson
Forensic Science - Undergraduate

Environmental DNA Analysis for Detecting Endangered and Invasive Species: Monitoring Eastern Hellbender, Tennessee Cave Salamander, Zebra Mussels, and Asian Carp in River Ecosystems

Environmental DNA (eDNA) analysis has revolutionized species detection and monitoring in aquatic ecosystems. This study applies forensic molecular methodologies to identify endangered and invasive species within river environments, specifically the Eastern Hellbender (Cryptobranchus alleganiensis), Zebra Mussels (Dreissena polymorpha), and Asian Carp (Hypophthalmichthys spp.). By isolating DNA shed by these organisms, eDNA techniques enable non-invasive species identification without direct capture. Targeting mitochondrial and nuclear genetic markers enhance detection accuracy. The 12 S ribosomal RNA region, a widely used mitochondrial gene, provides species-level resolution for vertebrates, while the 28S rRNA region, a nuclear marker, aids in distinguishing closely related taxa. Additionally, the cytochrome c oxidase I (COI) gene serves as a DNA barcoding marker, facilitating broad taxonomic identification of both vertebrates and invertebrates. This research employs advanced forensic techniques, including PCR amplification, gel electrophoresis, and nanopore sequencing, to analyze eDNA from river water samples. Species-specific primers are used to amplify target DNA sequences, with visualization via electrophoresis and confirmation through sequencing. The anticipated results will validate the presence of the target species, offering critical insights into their distribution.

By integrating molecular forensic methodologies with ecological research, this study underscores the effectiveness of eDNA analysis in conservation biology and invasive species management. Furthermore, it highlights the broader application of forensic DNA techniques beyond criminal investigations, reinforcing their relevance in environmental and conservation sciences.

8. Ahmed Alnassari
Faculty Mentor: Dr. Elizabeth Barnes
Biology - Undergraduate

Perceptions of Evolution and Evolution Education among Undergraduate Muslim Biology Students in the United States

Evolution is a fundamental concept in biology, explaining life's diversity and shared genetic heritage. However, ~36% of incoming U.S. biology students reject the idea of a common ancestor, a core tenet of evolution. A recent study found that perceived conflict between evolution and religion predicts students' acceptance of evolution more than their understanding of it or level of religiosity. This conflict stems from internal factors (e.g., personal beliefs) and external influences (e.g., community teachings). Most U.S. studies focus on Christianity, linking rejection of evolution to literal biblical interpretations. However, no study has explored how internal (e.g., religious beliefs) and external factors (e.g., learning environment, exposure to Christian creationist ideas) shape Muslim biology students' views on evolution. Muslim students also experience stigma tied to faith, gender, race/ethnicity, and science identity. Faith-based identities have become racialized within traditional racial and gender frameworks in the U.S. While both Christian and Muslim students report perceived conflicts between evolution and faith, Islam and Christianity have distinct ideologies. Research in Muslim-majority countries has identified sources of this conflict, but studies on Muslim students in the U.S. are limited.
To address this gap, we will conduct semi-structured interviews with Muslim undergraduate students across U.S. institutions in Fall 2024. Recruitment will target universities with sizable Muslim populations and broader sampling methods. Inductive coding will identify themes in student interviews, focusing on unique challenges and ways to improve evolution education. We hypothesize that perceived conflict is multifaceted, shaped by religiosity, the dominance of Christian culture, and the lack of religious role models in classrooms. Our goal is to develop inclusive teaching strategies that enhance Muslim students' learning experiences in biology.

9. Kathryn Baumann
Faculty Mentor: Dr. Warner Cribb
Geoscience - Masters

Mineralogical and Thermobarometric Evolution of The Chunky Gal Mountain Thrust Sheet, Southern Blue Ridge Mountains

Chunky Gal Mountain (CGM), Blue Ridge Mountains N.C., is a tectonic mélange consisting of intermediate to high-grade metamorphic rocks uplifted along the Chunky Gal Mountain fault (CGMF). Prior studies suggest CGM protoliths include pelitic to psammitic sedimentary and mafic to ultramafic igneous rocks (Lacazette and Rust, 1989; Peterson, 2014.) A detailed examination of CGM mineralogical assemblages and their characteristic metamorphic reaction types is necessary to understand CGM thermo-barometric evolution during tectonic uplift. This research 1) identifies principle metamorphic mineral assemblage reactions from crystal boundary and crystallographic properties and known mass balance relationships, 2) ascertains pressure and temperature ranges over which observed reactions and mineral assemblages formed, 3) correlates metamorphic facies and metamorphic grade to large-scale structural elements exposed along CGMF. The research contributes to a more advanced understanding of the geological history of the southern Blue Ridge Mountains and how minerals form from complex protolith compositions at high pressures and temperatures in Earth's deep crust. Samples represent an approximately 10-mile transect near the CGMF. Geochemical and mineralogical modeling reveals at least four reaction types representing prograde metamorphism of sedimentary protoliths: 1) Biotite + Quartz + Plagioclase + H_2O → Epidote + Muscovite (300-500°C; 3 to 7 kbar) 2) Epidote + Muscovite + Quartz → Garnet + Plagioclase + Biotite + H2O (450–650°C; 4–10 kbar) 3) Muscovite + Quartz + Plagioclase → Biotite + Garnet + Sillimanite + K-feldspar (650 – 750 °C, 4-10 kbar) 4) Biotite + Plagioclase + Quartz → Garnet + K-feldspar + H2O (650–750°C; 5–8 kbar). Prograde metamorphism of oceanic crust is represented by: 5) Plagioclase + Pyroxene + H2O → Hornblende + Albite + Quartz (500–700°C; 5–10 kbar) and 6) Amphibole + Plagioclase → Garnet + Pyroxene + Quartz + H_2O (650-900 °C, 6-10 kbar.)

10. Carly Altman
Faculty Mentor: Dr. Chaney Mosley
Mathematics and Science Education - Doctoral

An Exploration of Thwarted Belongingness and Perceived Burdensomeness Among Undergraduate Agriculture Students at A Non-land-grant University

This exploratory study investigates undergraduate agricultural students' feelings of thwarted belongingness and perceived burdensomeness and evaluates if these feelings are associated with various stressors accompanying college and post-secondary school. In agriculture fields and occupations, there is a presence of mental health diseases and suicidal ideation, and there is also an increasing risk of suicide among youths and undergraduate students. In this study, the Interpersonal Needs Questionnaire (Van Orden et al., 2012), created from the interpersonal theory of suicide (Van Orden et al., 2010), provides researchers and practitioners with measures to evaluate student respondent's feelings of thwarted belongingness and perceived burdensomeness. Responses were analyzed to investigate the relationship between the constructs and confirms the connections between thwarted belongingness and perceived burdensomeness. Results indicate that students experience varying degrees of TB and PB, with significant associations found between these constructs and factors such as age, employment, and living situation. The findings suggest that feelings of belongingness and burdensomeness are dynamically influenced by both interpersonal relationships and systemic structures within the educational setting. Results indicated that employment status influenced feelings of thwarted belongingness and perceived burdensomeness; age was also a predictor of low thwarted belongingness. The study recommends the development of supportive

interventions tailored to the needs of agriculture students, including peer mentorship programs, mental health workshops, and policy changes that prioritize student well-being. By addressing the specific stressors identified through this research, educational institutions can better support the mental health of agriculture students, potentially reducing their risk of suicide and improving their overall educational outcomes. A limitation of this exploratory study is a low response rate; future research will continue to study undergraduate agriculture students' mental health.

11. Jenna Brooks
Faculty Mentor: Douglas Adams
Forensic Science - Undergraduate

Effects of UV Exposure on Alternative Splicing of Daf-2 in C. elegans

Aging is characterized by the progressive decline of cellular functions, influenced by genetic and environmental factors. The insulin/IGF signaling pathway, particularly the daf-2 gene, plays a crucial role in longevity regulation in Caenorhabditis elegans. This study investigates whether UV-induced oxidative stress affects alternative splicing of daf-2 exon 4. We hypothesize that UV treatment will lead to alternative splicing events, altering daf-2 mRNA expression. To test this hypothesis, wild-type (N2) C. elegans were exposed to UV treatment, and cDNA was synthesized from extracted RNA. Reverse transcription-polymerase chain reaction (RT-PCR) was performed using primers targeting daf-2, and the amplified products were analyzed via agarose gel electrophoresis. Results indicated alternative splicing in both control and UV-treated samples, with distinct banding patterns. The control sample exhibited prominent bands at 1600 bp and 1800 bp, while the UV-treated group showed additional bands at 350 bp, 400 bp, and 550 bp, suggesting UV-induced splicing variations. These findings suggest that UV exposure may modulate daf-2 splicing, potentially influencing aging-related pathways. Future studies will employ quantitative RT-PCR to measure isoform expression levels and biochemical assays to determine functional implications. Understanding daf-2 splicing in response to oxidative stress could provide insights into aging and disease mechanisms, with implications for therapeutic strategies targeting age-related disorders.

12. Shaili Balampaki
Faculty Mentor: Dr. John Wallin
Computational and Data Science - Doctoral

EduSecure Database System

This project focuses on building a secure database with an emphasis on security.

13. Collin Clark
Faculty Mentor: Dr. Kiel Ormerod
Biology - Undergraduate

The Role of Projectin in Neuromuscular Physiology

The sarcomere, predominantly composed of actin and myosin filaments, is the well characterized repeating unit of striated muscle responsible for force generation. A sarcomere composed of only actin and myosin would have biophysical limitations that would not allow muscle to behave in the manner that it does, unless of course there are accessory proteins involved in muscle contraction. One such family of proteins is the elastic protein family, with the predominant elastic protein in humans being Titin, which is the largest protein found in humans. Defects in elastic proteins are thought to be responsible for various conditions such as dilated cardiomyopathy; one of the leading causes for heart transplants. Despite the apparent link between defects in elastic proteins and prevalent heart conditions little in Vivo research exists to understand the physiological role elastic proteins play in proper development and function muscle, partially due to the associated lethality associated with such experiments. In this research we seek to employ muscle fiber specific knockdown of Drosophila Projectin, thought to be a putative homolog of Titin A-band and one of two known Drosophila Titin homologs, to study the effects on gross muscle morphology and screen for changes at the sarcomere level.

14. Saroj Baral
Faculty Mentor: Dr. Joshua Phillips
Computer Science - Masters

Multimodal Deep Learning for Appendicitis Diagnosis: Integrating Clinical and Ultrasound Data

Diagnosing appendicitis remains a challenge in medical practice due to its varying symptoms across patients. While clinical scoring systems and machine learning models have been developed to predict diagnosis, they often rely on a single data modality. This study proposes a novel architecture that integrates both tabular clinical data and ultrasound images to improve diagnostic accuracy. The model utilizes pretrained ResNet-50 for feature extraction from images, a feedforward network to encode tabular data, and a fusion mechanism to combine these features for the final diagnosis. The proposed approach is expected to outperform existing methods, demonstrating an improvement in the AUROC metric compared to previous studies.

15. Christopher Clark
Faculty Mentor: Dr. Souvik Banerjee
Molecular Bioscience - Doctoral

Development of Potent Colchicine Binding Site Inhibitors for the Treatment of Taxol- Resistant Metastatic Melanoma

Metastatic melanoma is one of the deadliest types of skin cancer and is responsible for 80% of total deaths from skin cancer. According to the American Cancer Society, patients who have been diagnosed with distant metastasized melanoma only have a 5-year survival rate of 31%. Targeted therapies and paclitaxel are currently used in the clinic for treatment. However, prolonged usage of these therapies can lead to the development of resistance and rapid disease progression. Previous literature has indicated that colchicine binding site inhibitors (CBSIs) are promising candidates for the treatment of resistant variants of melanoma. In this study, we designed a new series of CBSIs from a novel scaffold with the assistance of molecular modeling. Through structure-activity relationship studies, we optimized the scaffold to produce our lead compound 4p. This compound was confirmed as a CBSI and shown to have potent antiproliferative activity in the 15-20 nM range against a diverse panel of melanoma cell lines, including taxol-resistant variants. We showed in vitro that treatment with this compound inhibits cancer cell behavior such as cell migration, invasion, and colony-forming ability. In vivo, treatment with compound 4p inhibited tumor growth in an A375 taxol-resistant xenograft mouse model. Immunohistochemistry studies showed significant immune cell infiltration into the tumor, which indicated immune system involvement. These studies were repeated in an immunocompetent B16-F10 xenograft mouse model. Treatment with 4p significantly reduced tumor volume, weight, and affected tumor morphology. Further studies are being performed to assess the underlying in vivo mechanisms of compound 4p and on compound 21, a newly synthesized analog of 4p that has a 3-5x improvement in antiproliferative activity in vitro.

16. Devin Barnett
Faculty Mentor: Dr. Cole Easson
Biology - Undergraduate

Unidentified Creatures Altering Our Water Supply? Genetic Identification of Tennessee Sponges

I am comparing the genomic sequences of sponges found in Tennessee, whose sequences currently exist in no database, with their contemporaries that have been documented throughout the world. By doing this, I hope to find how much, if any, genetic divergence has occurred between these species that are supposed to have been separated for millions of years. Depending on how much genetic variation is found, further studies could open up. For example, if very little genetic variation is found between the two sponge groups, it may be possible to track those sponge lineages to sponges that may have been brought unknowingly on vessels that traversed the Atlantic. Or, if there is an abundance of variation, we may find that the sponges have grown far enough apart genetically to no longer be considered the same species. Regardless of the findings, finally getting proper genetic sequences of Tennessean sponges into the world databases will further scientific knowledge and is a worthy goal to pursue.

17. Elizabeth Counts
Faculty Mentor: Dr. Elizabeth Ann Smith
Nutrition and Food Science - Undergraduate

Examining Processed Foods in Food Banks and the Presence of Chronic Diseases in Food Bank Clientele

Food insecurity affects millions of Americans and puts them at an increased risk of developing chronic disease. Food banks are essential in improving food access for this population. However, previous studies have identified gaps in the nutritional quality of items donated to food banks, thus decreasing clients' access to nutritionally adequate food. The first part of this study aimed to examine the presence of chronic disease in food bank clientele by distributing a survey to clients in the waiting room of a local food bank. The second part assessed the nutritional quality of donated items based on their level of processing using the NOVA Food Classification tool. The study found that the majority of food bank clients had been diagnosed with a diet-related chronic disease, and that slightly over half of donations were ultra-processed foods. This information can be used to form collaborative approaches between food bank staff, their clients, community leaders, and donors to help improve access to nutritious food for those facing food insecurity.

18. Keegan Barrett
Faculty Mentor: Dr. Warner Cribb
Geoscience - Undergraduate

Water Quality Assessment of Developing Nashville Area

Our research focuses on observing, testing, and comparing water and sediment quality samples from an underdeveloped region of the Cumberland River watershed. The research area is located 2 miles E-SE of downtown Nashville, TN, along the west bank of the Cumberland River in Shelby Park, where several low-order streams empty into the Cumberland River. Similarly, the broader region of the Cumberland River watershed, east of Nashville, poses important sample locations for the study, including Coopers Creek, Seiver Lake, Old Farm Pond, and Pages Branch. In concert with online USGS water quality data, we investigate surface water and sediment pollutant correlations between urban development and neighboring water systems. Sediment samples are obtained by capturing suspended sediments or directly from the stream banks. Chemical analysis of surface water and sediments is conducted by inductively coupled plasma mass spectrometry. Results from our tested samples provide concentrations of environmentally sensitive elements such as Bromine, Mercury, Sulfur, Copper, Lead, Tellurium, Chromium, and Arsenic. This chemical data is paired with an analysis of online USGS data of water quality assessments in the study area's water systems to investigate potential historical trends in pollution and urban development.

19. Alec Creasy
Faculty Mentor: Dr. Joshua Phillips
Computer Science – Masters

Comparing Performance of Recurrent Neural Network Architectures Using Data on Wildfire Propagation

In machine learning, there are many studies being performed that allow computers to be able to learn patterns and generalize unseen data to make predictions. One such area of study involves using machine learning techniques to predict wildfire propagation. In these endeavors, Artificial Neural Networks (ANNs) have been a popular choice to build models to solve this task. Within these models, a subset of ANNs, Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) are a popular choice for predicting the likelihood of a fire spreading across a region over a specified number of time steps. Most existing research makes use of the Long Short-Term Memory (LSTM) variant of the RNN architecture, a special type of RNN that can retain long-term context amongst many time steps in training. While the LSTM is a popular architecture used for wildfire propagation prediction, the Gated Recurrent Unit (GRU) RNN is a simplified version of the LSTM architecture. The GRU has been used in a very limited capacity for this task, and there is currently no study comparing the two architectures' benchmarks for wildfire propagation prediction. This study aims to discover the performance differences between the LSTM and GRU architectures on wildfire propagation prediction tasks, utilizing existing research using a CNN and LSTM hybrid model and drawing comparisons using quantifiable metrics.

20. Tyler Baxley
Faculty Mentor: Dr. Charles Chusuei
Chemistry - Undergraduate

Room-Temperature Electrochemical Cannabinoid Solution Assays

With the proliferation of cannabis-derived products in the medicinal market, there is a growing need to accurately and efficiently assay cannabidiol (CBD), cannabinol (CBN), and cannabigerol (CBG). Room-temperature analysis improves the reliability of results by reducing the potential of thermal degradation accompanying traditional methods, e.g., HPLC. Using cyclic and linear sweep voltammetry (CV and LSV respectively), CBD, CBN, and CBG sensor development was explored using carboxylic acid functionalized multiwalled carbon nanotubes within the 10– to- 100 micromolar concentration range in Britton-Robinson buffer solutions.

21. Bailey Davenport
Faculty Mentor: Dr. Ryan S. Jones
Biology - Undergraduate

Biological-Conservation Education Clinical Interview Analysis

This clinical interview with the Chair of Middle Tennessee State University's Biology Department and a Graphic Design Undergraduate student revealed differences in valuing, participating in, and learning about Conservation in Biology. This interview aimed to discover how each participant understood conservation. The expert and novice were asked questions regarding multiple facets of biological conservation and how it had been taught to them. These questions focused on their academic history, personal experience, and the perceived value they held for conservation. While the expert depended largely on academic knowledge and diversified examples, the novice focused primarily on campaigns and personal experience. According to their definitions, neither participant engaged in conservation regularly, but both viewed the subject as imperative in Biological Education. To improve conservation education, Biology professors and teachers may benefit from partaking in conservation efforts, organizations, or practical activities.

22. Nyah Bentley
Faculty Mentor: Dr. Daniel Erenso
Physics and Astronomy - Undergraduate

Plasma Formation from Porcine Blood Using Sunlight and an Ultraviolet Laser Trap

Animal blood waste is often discarded, contributing to environmental pollution. This research investigates the potential of repurposing porcine blood as a sustainable energy source by studying plasma formation under exposure to sunlight and an ultraviolet (UV) laser trap. The study aims to analyze the plasma's temperature, radiated energy, and energy input requirements to determine whether incident light energy can generate usable clean energy. Building on previous research with infrared laser trapping, this experiment employs a 305 nm UV laser at 15 W and focused sunlight. Blood samples are prepared on glass slides, exposed to these energy sources, and recorded using Infinity Capture while power measurements are taken with StarLab. Video analysis is conducted using Python-based RGB frame extraction and intensity conversion, allowing for the estimation of plasma temperature via Stefan-Boltzmann's Law and wavelength using Wien's Displacement Law. Power data is further analyzed to evaluate energy absorption and emission. Preliminary results from infrared laser experiments demonstrate an inverse relationship between temperature and wavelength, consistent with Stefan-Boltzmann and Wien's laws. Data visualization using OriginPro highlights trends in plasma behavior. This study extends those findings to UV radiation, offering insights into the interaction between biological matter and high-energy light sources. The research enhances understanding of UV radiation's effects on organic materials, advances expertise in optics and laser physics, and contributes to sustainability-focused energy studies. Mentored by Dr. Erenso, this work integrates experimental physics, data analysis, and programming, fostering valuable research skills. The outcomes will inform future applications of biological matter in clean energy technologies, addressing both environmental concerns and energy challenges.

23. Robert Davis
Faculty Mentor: Dr. Rebecca Seipelt
Biochemistry - Undergraduate

Assessing the Relationship Between Deep Summer Precipitation and Biodiversity in the Stones River Watershed

To better care for our natural world, it is important to understand how environmental fluctuations impact biodiversity. One environmental factor that fluctuates extremely is precipitation. Studies have shown that climate changes decrease biodiversity, however, research on the effects of recent precipitation on biodiversity is lacking. To gain a better idea of how summer precipitation affects biodiversity in our local Watershed, we conducted a study of total August precipitation and biodiversity level in September using eleven sites within the Stones River Watershed. I hypothesized that August precipitation level would not show correlation to biodiversity because rainfall would not vary significantly between sites, as they are relatively close together. First, we collected three liters of water from Stones River at eleven sampling sites in early September, and utilized vacuum filtration, DNA extraction, PCR, and agarose gel electrophoresis to obtain and amplify environmental DNA for genetic sequencing. Then, sequences were analyzed for species and biodiversity using the DADA2 and phyloSeq R packages. Alpha diversity (Inverse Simpson) ranged from 16.6 to 123.2. Next, I utilized WeatherUnderground precipitation data to find the precipitation recorded for August 2024 at the weather station nearest each collection site. Rainfall ranged from 2.29 cm to 8.15 cm. Finally, I performed a correlation analysis between the alpha diversity and August precipitation at each collection site, which found that there is little to no relationship (R2 = - 0.1846). Overall, the study concluded that biodiversity in the Stones River Watershed is fairly high and found no relationship of August precipitation level to September biodiversity. Next, we intend to investigate the relationship using 1) a larger number of years, 2) whole summer precipitation levels, and 3) whole year precipitation levels. Additionally, it may be advantageous to consider that the relationship between recent precipitation and biodiversity may not be linear.

24. Chris Bonnesen
Faculty Mentor: Dr. Jeremy Strayer
Mathematics and Science Education - Doctoral

Understanding Undergraduate Views of the Nature of Mathematics

This poster presents results of a study investigating students' views of the nature of mathematics (NOM) using a survey developed and implemented by the authors. Participants included over 60 undergraduate students enrolled in various mathematics courses (Calculus I, Calculus III, Mathematics for elementary education, and Abstract Algebra) at a public 4-year university in the Southeastern United States. Participants completed a survey comprised of five demographic items and twelve NOM items intending to measure distinct dimensions of one's philosophy of mathematics—whether: (1) mathematics exists independently of humans, (2) nonphysical abstract mathematical objects exist, and (3) mathematics is more conceptual or procedural in nature. Cognitive interviews revealed promise for survey validity of dimensions (1) and (3) and difficulty validating dimension (2). Latent profile analysis techniques revealed three subgroups of participants: Conceptual Platonists, Centrists, and Humanists.

25. Ian Ebert
Faculty Mentor: Dr. Greggory McPherson
Physics and Astronomy - Undergraduate

Soap Bubbles as Optofluidic Lasers

Soap bubbles display some fascinating properties that have been admired by many for years. They show unique interference colors and have been occasionally studied for their optical phenomena, however they have not been used for practical applications so far. We investigated the use of a dye-doped soap bubble as an optical detector using an NdYAG laser to excite a fluorescent dye in a bubble. This causes a phenomenon known as Whispering Gallery Modes, named after the Whispering Gallery in St Paul's Cathedral, to form in the thin film of the bubble. Whispering Gallery waves form when the laser, guided by total internal reflection, constructively interferes with itself and causes strong resonance when the circumference of the bubble is an integer of the laser's initial wavelength. We then compared the diameter of the bubble to the wavelength of the laser light using a spectrometer to investigate whether there was a relationship between the two. This could find use in a quantum computer to detect electromagnetic fluctuations that could harm it, and research into thin film and cavity optomechanics.

26. Jenna Brooks
Faculty Mentor: Douglas Adams
Forensic Science - Undergraduate

The Science of Death: Autopsy, Postmortem Changes, and Wound Analysis

Death investigation is a vital component of forensic science, aiming to resolve unexplained, suspicious, or violent deaths. Such investigations rely on a multidisciplinary approach, incorporating expertise from pathologists, toxicologists, and other specialists to determine the cause, manner, and time of death. This poster explores key elements of death investigations, including autopsies, postmortem changes, and wound analysis, emphasizing their role in uncovering critical evidence and enhancing public trust in the justice system. Postmortem changes, such as algor mortis, rigor mortis, and livor mortis, provide essential clues to establish the postmortem interval (PMI). Wound analysis further aids in determining whether injuries occurred pre- or post-mortem, as well as distinguishing between sharp and blunt force trauma. Autopsies, comprising external examinations and internal dissections, reveal hidden injuries or diseases and are instrumental in classifying deaths as natural, accidental, suicidal, or homicidal. The dataset featured in this study comprises survey responses assessing public knowledge and confidence in death investigations. Results reveal that most participants were neutral or only somewhat confident about processes such as forensic autopsies, wound analysis, and time-of-death estimation. This highlights a significant gap in public awareness and understanding, emphasizing the need for educational outreach to bridge this divide. Technological advancements in forensic science, including histological exams and insect activity analysis, have significantly improved the precision of investigations. However, the rise of private autopsies presents ethical and legal challenges, particularly when findings conflict with public autopsies. In conclusion, the integration of advanced methodologies, multidisciplinary collaboration, and public education enhances the accuracy and reliability of death investigations, contributing to the resolution of cases and upholding legal standards.

27. Hamza Fareed
Faculty Mentor: Dr. Kiel Ormerod
Biology - Undergraduate

Role of Elastic Proteins in Cardiomyocytes

The circulatory system constantly supplies the trillions of cells in the human body with oxygen and nutrients, while simultaneously removing waste and ensuring metabolic processes. At the core if it is the heart, 99% of which is composed of cardiomyocytes: a specialized form of muscle cells that allow the heart to pump blood. Cardiomyocytes are made up of sarcomeres that are formed by overlapping actin and myosin filaments. These sarcomeres are home to the largest protein in the body, titin, which is an elastic protein that gives the heart its plasticity. This allows the heart to have control over the heart rate and stroke volume. This study will examine the role of the Salimus and Projectin proteins, which are homologs of titin, found in Drosophila melanogaster (fruit flies). Previous work has been done to study these proteins in skeletal muscles; this research seeks to research Salimus and Projectin to better understand the mechanisms of titin and its functions in cardiomyocytes. This will be done by with the selective knockdown of the Salimus and Projectin proteins through the use of RNA interference (RNAi). The main hypothesis of this research is: the disruption of the Salimus and projectin will damage the structural integrity and compromise the contractility of cardiomyocytes. The experiment will use the GAL-4/UAS system to produce drosophila that expresses fluorescence in their heart. This allows us to visualize the change in heart rate. This will enable the viewing of the changes in heart rate through fluorescent microscopy. Immunohistochemistry with Phalloidin-GFP will also be conducted to view the changes in the ultrastructure of the heart.

28. Kara Brown
Faculty Mentor: Dr. Alyssa Logan
Horse Science, Equine Education - Masters

Creating and Hosting a Horsemanship Clinic Program and Show Management at a Youth Competition

Horsemanship clinics provide riders with professional instruction to improve their communication and riding skills. However, Tennessee currently lacks sufficient clinic opportunities. To address this, Middle Tennessee State University (MTSU) aims to develop a traveling horsemanship clinic led by equine education graduate students. Modeled after similar university programs, the clinics will focus on riding techniques, confidence, and horse safety, incorporating both mounted and classroom sessions. The first clinic, designed for adults in ranch horse disciplines, will be held at Hurricane Creek Ranch in Lebanon, TN, on March 8th. The first step in development is an interest survey to determine the demand for locations, disciplines, and rider experience levels. An application process will follow, requiring participants to describe their horse and personal riding goals. Participants must provide their own safe horse, and any horse deemed unsafe will not be allowed to continue. Graduate student instructors will be selected based on clinic needs, with a faculty member overseeing the program. Instructors will develop lesson plans for each clinic, contributing to a structured curriculum bank for continued development and refinement. Additionally, MTSU graduate students can gain industry experience through a paid internship with the Interscholastic Equestrian Association (IEA) at Western Nationals in Fort Worth, Texas. The intern will manage paddock operations, including organizing horses, ensuring timely mounting, and coordinating with show staff. These combined experiences will enhance coaching, event management, and program development skills. By creating a sustainable foundation, MTSU aims to expand the clinic's reach while preparing graduate students for careers in equine education, competition management, and group instruction.

29. Mary Foley
Faculty Mentor: Dr. Elizabeth Barnes
Mathematics and Science Education – Post Doctoral Fellow

CURE Inception: Teaching Undergraduate Biology Students Science Communication About Culturally Controversial Topics by Having Them Research How Undergraduates Currently Communicate

Undergraduate biology students rarely receive formal training in communicating with non-scientists (Brownell et al., 2013), which may lead to ineffective strategies that contribute to public mistrust of science. Building trust is a key goal of effective science communication, particularly for culturally controversial science topics (CCSTs) such as evolution, climate change, and vaccines (Fiske & Dupree, 2014). Undergraduate biology students may be well-positioned to communicate about CCSTs, as they are more culturally diverse than professional scientists while still possessing a college-level biology education that lends them credibility within their communities (Bowen et al., 2023). Yet, science education researchers are just beginning to explore how undergraduate biology students currently approach discussing CCSTs with non-scientists and how to increase key targets that predict students' communication skills. To address this gap, we are developing a Course-based Undergraduate Research Experience (CURE) that trains students in both the scientific process and science communication. This course will allow students to (1) conduct authentic social science research by analyzing communication strategies among biology undergraduates and (2) gain experience in study design, qualitative research, and quantitative data interpretation while developing effective communication skills for non-scientific audiences. To assess our learning outcomes, we will evaluate students' research skills, as well as their knowledge, values, and self-efficacy in communicating CCSTs. Additionally, we will assess the course's effectiveness in providing an authentic and engaging research experience. We anticipate that this CURE will establish baseline data to inform improvements in undergraduate science communication education, equipping students with essential skills to combat misinformation and address scientific controversy within their communities.

30. Kate Coscia
Faculty Mentor: Dr. Elizabeth Barnes
Mathematics and Science Education - Doctoral

Exploring the Impacts of Science Communication Instruction on Introductory Undergraduate Biology Students' Ability to Communicate About Culturally Controversial Science Topics

Undergraduate biology students are already communicating about controversial science topics but feel unprepared, and many are not using effective tactics. Despite their desire to learn to communicate effectively, training opportunities remain limited. Most students will not receive training unless they seek it out as an extracurricular course. To explore whether we could implement more accessible training, we incorporated a novel short science communication module into an introductory biology course. During instruction, students learned about effective and ineffective science communication tactics, their potential to serve as boundary spanners in their communities, and the importance of establishing cultural competence. They practiced in class using worksheets where they explained how they would communicate with someone who denied climate change both pre- and post-instruction. We then asked them to transfer their knowledge to another controversial topic and respond to someone hesitant about vaccines. Analysis of students' worksheets showed that their pre-instruction responses overemphasized the transmission of facts and underemphasized relational approaches. Post-instruction, students reduced ineffective tactics related to climate change and increased their use of effective, relational approaches,

which also transferred to vaccine hesitancy. Analysis of student interviews 2-5 months later suggested that instruction impacted their science communication experiences. Before instruction, students described using a deficit approach but described using more dialogue and relational approaches after instruction. Students also described the value of science communication, the positive impacts of instruction, and areas where they may need more support. These findings suggest that including a single science communication module in an introductory undergraduate biology course increased students' value of science communication, their science communication self-efficacy, and their use of effective science communication tactics. This may lead to an increase in students' willingness to engage in discussions about controversial topics and their ability to do so effectively, which could foster better relationships between science and society.

31. Rachana Gaire
Faculty Mentor: Dr. Joshua Phillips
Computer Science - Masters

Predicting Agricultural Pest Outbreaks and Seasonal Insect Trends

Agriculture has seen a drop in food production in recent years. One of the main reasons is the rise in pest outbreaks, which destroy crops and cause economic losses for farmers. Traditional pest control measures rely on reactive approaches, which can result in large crop losses just before the initiation of treatment. The research will focus on one of the most destructive insect pests, aphids, which cause severe damage to crops and their food productivity. This study focuses on two powerful machine-learning models, ARIMA and LSTM, using environmental factors such as humidity, temperature, rainfall, and soil temperature data to forecast aphid outbreaks and seasonal trends. By comparing the predictions of both models, we aim to create a more effective, data-driven early warning system. This will help farmers and agricultural researchers take proactive measures for better pest management. We anticipate that we will see spikes weekly or monthly in aphid count, normal levels from a huge increase, predict when the population might go beyond the normal level, and find a potential outbreak.

32. Grayson Cunningham
Faculty Mentor: Dr. Jorge Vargas
Electro-Mechanical Engineering – Undergraduate

Ideal Workstation for Automotive Engineering

The development of autonomous vehicles (AVs) requires rigorous simulation and testing to ensure safety and reliability. Motion platforms enable engineers to physically experience AV behavior before real-world deployment, refining control systems and assessing safety risks. However, AV workstations often lack standardized motion integration, limiting testing efficiency. This research proposes an ideal automotive engineer workstation, integrating a 6-degree-of-freedom (6-DOF) motion platform with MATLAB and Simulink-based simulations for enhanced validation. This study involves analyzing motion platform dynamics and evaluating ergonomic factors to optimize the workstation for AV engineers. A Simulink-based motion simulation was developed to compare 3-DOF vs. 6-DOF motion platforms, modeling key movements such as pitch, roll, yaw, surge, sway, and heave. The system employs variable input signals to replicate real-world driving conditions and integrates a PID control system for stability and response analysis. Results indicate that 6-DOF motion platforms offer superior real-world accuracy compared to 3-DOF platforms, reducing deviations in AV test scenarios. Additionally, an OSHA ergonomic assessment highlights improvements in engineer comfort and efficiency. The findings of this research provide a foundation for standardizing automotive engineer workstations, leading to safer, more accurate AV testing environments.

33. Tanya Garain
Faculty Mentor: Dr. Souvik Banerjee
Molecular Bioscience - Doctoral

Design, Synthesis and Biological Evaluation of Quinoline/Dihydroquinoline Based Colchicine Binding Site Inhibitors for Treatment of Metastatic Resistant Cancer

Microtubules (MT) are a crucial component of the cellular cytoskeleton and comprise alpha and beta heterodimers. Microtubules have a variety of cellular functions, like proliferation, intracellular trafficking, mitosis, etc. The MTs experience cyclical periods of polymerization (GTP-tubulin is added to the growing end of the β subunit) and depolymerization (hydrolysis of β-bound GTP to GDP), and this rate of polymerization and depolymerization leads to dynamic instability. For successful mitotic events, cell development, and cell division, dynamic instability is significant. Anti-tubulin drugs alter the dynamics of MTs, which are fundamentally necessary for DNA segregation and cell division during mitosis, hence eliminating cancerous cells. Although this class of drugs has been thoroughly investigated and shown to be effective against various cancer types, there are still major challenges to overcome, such as narrow therapeutic window and the emergence of drug resistance. Because of their benefits over other MT-targeting drugs, colchicine-binding site inhibitors (CBSIs) are a subject of ongoing research, however, balancing their potency and toxicity is an issue that needs to be resolved. Crolibulin is one such tubulin polymerization inhibitor that is active against tumor angiogenesis and shows anti-cancer activity. It went up to Phase I/II clinical trials with cisplatin for anaplastic thyroid; however, due to its strong cardiovascular and neurotoxicity, it could not be used clinically.

Taking inspiration from such known inhibitors, the goal of this project is to generate MT destabilizing agents that bind to the colchicine binding site (CBS). Our analysis from molecular modeling suggests that inhibitors with quinoline or dihydroquinoline as a core template can compensate for the interactions required between the ligand and the CBS and could have improved stability and solubility. Synthesis of such scaffolds followed by preliminary cell viability assay (MTT assay) indicated that these compounds are biologically active and further structural optimization could lead to better potency. We aim to design, synthesize, and assess the biological efficacy, mechanism of action, and metabolic stability of more such unique scaffolds that could circumvent existing challenges and are highly potent.

34. Anna Davis
Faculty Mentor: Dr. Rachel Leander
Mathematics - Masters

Modeling Asymmetric Cell Division for Comparison to Florescent Confocal Microscopy Data

Cryptococcus neoformans are fungal pathogens found most commonly in soil and bird droppings. This pathogen infects cells found in the lung. While most healthy individuals are not impacted by exposure to these fungi, those who are immunocompromised may experience lung infections or meningitis from Cryptococcus neoformans. Our biological collaborators have been studying the replication of this fungal pathogen in fetal liver-derived alveolar-like macrophages (FLAMs) by using florescent confocal microscopy. Unlike the standard cell line typically used with research about Cryptococcus neoformans, J774s, FLAMs behave more like immune cells from the lung. In this poster, we present a model for the asymmetric cell division of Cryptococcus neoformans in FLAMs for comparison to the empirical data compiled by our biological collaborators. Quantifying changes in growth and division under perturbations and assigning statistical significance requires a model of the expected growth and division pattern. A small population size combined with asymmetric division makes continuous exponential growth inappropriate for quantifying changes in growth rate and assigning statistical significance. Our model is useful to our biological collaborators because it counteracts some of the difficulties of collecting empirical data, such as the rapid division of Cryptococcus neoformans and the difficulty of reliably detecting fungal cells that are very small or in clumps.

35. Ellaleigh Hall
Faculty Mentor: Dr. Rebecca Seipelt
Biochemistry - Undergraduate

Nitrogen and Biodiversity in the Stones River Watershed

There are a multitude of factors that influence freshwater biodiversity. I am studying our local watershed's nitrogen levels, a key factor in biodiversity. Fertilizers, sewage, and animal waste are the primary sources of nitrate contaminants in freshwater. High nitrate levels disturb the reproduction and development of aquatic life and can stimulate higher levels of unwanted algae and plants, negatively impacting biodiversity. These high levels also affect humans directly through drinking water, which can disturb the thyroid gland. Here, we study how water chemistry from a local water source, the Stones River Watershed, affects the diversity of its species. I hypothesize that there will be an inverse relationship between levels of nitrogen and species richness. This research involves two water samples from 11 sites, testing each for specific water parameters, filtration, eDNA profiling, and data analysis. The conclusions show that nitrate levels between sites ranged from 0 to 3 mg/L. Nitrite levels were all 0 mg/L. The research includes a brief comparison of plotted alpha and nitrate level data for analysis. The graph shows a negative slope for the line of best fit. The results indicate an inverse relationship between biodiversity and nitrogen levels across all sites tested, although the R2 value is relatively low, indicating a weak correlation. This result supports my hypothesis. Another figure created from this research shows changes in species richness, comparing findings from the Fall 2023 study to the Fall 2024 study. The results show that most species have increased in richness over the last year. Overall biodiversity has increased since the previous year, and nitrogen levels decrease as biodiversity increases.

36. Ayodele Demuren
Faculty Mentor: Dr. Mina Mohebbi
Engineering Technology, Occupational Health and Safety – Masters

Environmental Impacts of Emerging Photovoltaic Technologies A Focus on Toxicity, Resource Use, and Carbon Footprint

The rapid advancement of photovoltaic (PV) technologies has positioned solar energy as a cornerstone of global renewable energy strategies. However, the environmental impacts of emerging PV technologies, particularly in terms of toxicity, resource use, and carbon footprint, remain underexplored. This study will conduct a life cycle assessment (LCA) to evaluate the environmental impacts of next-generation PV technologies, including perovskite, organic, and tandem solar cells, in comparison to conventional silicon-based PV systems. The analysis focuses on three critical dimensions: the toxicity of materials used in manufacturing, the sustainability of resource extraction and utilization, and the carbon emissions associated with production, deployment, and end-of-life disposal. It is understood that while emerging PV technologies offer significant improvements in energy conversion efficiency, they often rely on toxic materials, like lead in perovskite cells and indium in organic PVs, raising concerns about environmental and human health risks. Resource use is also a critical issue, as the extraction of rare earth elements and other materials required for advanced PVs can lead to ecological degradation and supply chain vulnerabilities. The carbon footprint of emerging PV technologies varies widely, with some such as perovskite solar cells (PSCs), quantum dot solar cells (QDSCs), and organic photovoltaics (OPVs), exhibiting lower emissions during manufacturing but higher impacts during disposal due to complex recycling requirements. The study will highlight the need for innovative material design, improved recycling infrastructure, and stringent regulatory frameworks to mitigate the environmental impacts of next-generation PV technologies. By integrating sustainability into the development and deployment of

these technologies, the solar energy sector can achieve a balance between efficiency gains and environmental stewardship, ensuring a cleaner and more sustainable energy future. This research will provide a critical foundation for policymakers, industry stakeholders, and researchers to prioritize environmentally responsible PV innovation.

37. Sophia Harris
Faculty Mentor: Dr. Mary Farone
Biology - Undergraduate

Analysis of the Intranuclear Infection and Growth of "Candidatus Berkiella aquae" within Spodoptera frugiperda

Water-residing bacteria are a common prey for amoebae. Their predation on microorganisms is responsible for managing microbial populations in aquatic environments. These microorganisms are engulfed by the amoebae, with some surviving engulfment, amoeba-resistant bacteria (ARB), and fewer using the amoebae as a host for replication. "Candidatus Berkiella aquae," HT99, is an intranuclear novel bacterial strain purified from amoebae samples found in an outdoor hot tub biofilm in Cookeville, Tennessee. This bacteria was found to have a strong resemblance to the human pathogen Coxiella burnetii; however, HT99 cannot infect mammalian cell lines. This study assessed Spodoptera frugiperda ovarian tissue, Sf9, cells for potential HT99 infection. Once confirmed, Sf9 cells infected with HT99 and non-infected controls were cultured at various times (0 hours, 24 hours, and 48 hours). Giemsa staining was used to stain the DNA (nuclei) of cells, making it possible to quantify the number of infected cells within the total cell population at each time point. Additionally, qPCR was performed to measure the changes in HT99 concentration in the insect cells throughout the infection. Results confirmed that HT99 passed through amoebae, can infect and proliferate within the nucleus of insect cell lines. Giemsa staining revealed HT99 infection in Sf9 cells, with clear signs of bacterial growth after 48 hours. The qPCR results showed an increase in the calculated genomic equivalence at 48 hours compared to the 0-hour samples, indicating intranuclear bacterial proliferation. Further studies can investigate whether HT99 can infect mammalian cell lines when harvested from Sf9 cells. If mammalian infections remain unsuccessful, an alternative to this is testing HT99's ability to infect non-mammalian cell lines, such as those from arthropods and amphibians.

38. Lydia Folorunsho
Faculty Mentor: Dr. Jessica Arbour
Biology - Undergraduate

Exploring Neural Anatomy in Percid Fishes

Fish represent half of vertebrate species, yet how selection drives the organization of their brains is poorly understood compared to vertebrate groups like birds and mammals. A few recent breakthrough studies have shown ecological roles (e.g., coastal vs. open ocean) have a significant impact on neuroanatomy in sharks, but almost no comparative studies have been conducted in the more diverse bony fishes. The Percidae family (perch, walleye and darters) is a highly diverse family of bony freshwater fish in the United States (n > 240). Members of this family vary in a multitude of ways ranging from appearing in various habitats (benthic and pelagic forms, swift and calm waters), sexual dichromatism, and disparities in parental investment. This study focuses on the neuroanatomical diversity of Percid fish and seeks to understand how these differences may play a part in the fish's lifestyle and behavioral characteristics. Most percid species are small-bodied fishes, and we use newly developed high resolution, digital dissection approaches to permit the first 3D reconstruction of their brain anatomy. From an extensive database of iodine contrast-

enhanced CT scans (diceCT) of the heads of –75 percid species, we produced 3D models of key species consisting of both benthic and pelagic lineages using the CT scan segmentation program Mimics. We will collect data pertaining to the size of several major structures (e.g., optic tectum, forebrain, hypothalamus) key to locomotory, sensory and behavioural traits. Preliminary tests will investigate if brain organization (i.e., relative sizes of different major structures) is linked to either of the two factors (habitat and sexual selection) and provide power tests for a larger study.

39. Joy Harrison Creighton
Faculty Mentor: Dr. Jason Jessen
Molecular Bioscience - Doctoral

Frizzled 7- dependent regulation of planar polarity and cell migration in zebrafish gastrulation

Planar polarity is a context-dependent process vital for shaping the embryonic body plan. Key to planar polarity is the intercellular communication necessary for the uniform organization and orientation of actin-rich structures across a population of cells. In zebrafish (Danio rerio), loss of planar polarity during the gastrulation cell movements of convergence and extension produces severely misshapen embryos with defective dorsal-ventral and anterior-posterior body axes. Gastrula cells exhibit distinct planar polarity-dependent behaviors, including elongation and mediolateral alignment, as they engage in collective migration. Studies in the fly (Drosophila melanogaster) established that a core six-protein complex is required for planar polarity of actin structures in wing epithelia. Here, transmembrane proteins Frizzled and Van Gogh were identified as important regulators of planar polarity. In contrast to zebrafish Van Gogh (Vangl2), data is limited regarding the cellular requirements of Frizzled homologs for planar polarity in gastrulation. We have therefore undertaken a comprehensive analysis of Frizzled 7 (Fzd7) function during the establishment of planar polarity and the collective migration of zebrafish gastrula cells. We first confirmed Fzd7 was required for planar polarity-dependent cell behavior, identifying reduced cell orientation and impeded cell migration when Fzd7 was lost. Subcellular investigation found that Fzd7 promoted mediolateral polarization of large actin-rich membrane protrusions and stabilization of small filopodia-like protrusions. We also observed increased fibrillogenesis with the extracellular matrix (ECM) in fzd7-null embryos without increased expression of ECM-related proteins, which could be an indirect result of reduced RhoA expression. To better understand these findings, we are currently investigating Fzd7 function in RhoA and JNK/c-Jun actin polymerization pathways. Preliminary results indicate increased expression of Rac1 during gastrulation, suggesting a shift to JNK/c-Jun actin polymerization activation. We therefore propose Fzd7 is essential to planar polarity, regulating actin for uniform cell orientation through protrusion modeling and promoting efficient migration through fibronectin assembly.

40. Alyssa Freeman
Faculty Mentor: Dr. Grant Gardner & Dr. Sarah Bleiler-Baxter
Mathematics and Science Education - Doctoral

Measuring STEM Department Teaching Culture: A Survey Developed using Self-Determination Theory

While research has determined many classroom teaching practices can promote student retention and diversity (Theobald et al., 2020), undergraduates are commonly taught through instructor-centered, lecture-based courses (Stains et al., 2018). Therefore, nationwide teaching reform is needed to recenter our students in the classroom and meet the future scientific demands of our country. To meet these goals, instructors may need support from their department to motivate them to incorporate more evidence-based teaching practices into their classrooms. This project aims to create departmental cultures that are collaborative, inclusive, and centered on growth, which can ultimately lead to more inclusive teaching practices to support student retention and success. In the first phase of this project, I have focused on developing a survey to characterize the current teaching cultures across multiple STEM departments with the psychological needs of Self-Determination Theory (Deci et al., 2017). The psychological needs are competence (instructors' need to feel knowledgeable and confident in their ability to use practices that support the learning of all students), autonomy (instructors' need for self-governance to engage in pedagogical advancements), and relatedness (instructors' need to "fit in" and be valued and respected with teaching colleagues) which must be met for instructors to have optimal opportunities to succeed in supporting student learning and success. When considering an instructor's psychological needs, it is also essential to consider the teaching culture the instructor works within. Therefore, I have also used Self-Determination Theory as a lens to understand the components of relatedness, competence, and autonomy within the teaching culture of STEM departments. To our knowledge, no instrument exists to characterize STEM department teaching culture using the psychological needs of Self-Determination Theory. Thus, this study aimed to develop this novel survey instrument.

41. Sarah Hartman
Faculty Mentor: Zac Bettersworth
Mathematics and Science Education - Doctoral

Interactive Digital Activities in Real Analysis for In-Service Teachers

In this poster presentation, we present pilot data describing how secondary mathematics teachers enrolled in a fully online, Real Analysis course in the Southeastern United States engaged with interactive digital activities. Further, we describe what mathematical meanings were elicited in this context during semi-structured interviews where students engaged with mathematical tasks via the activities. These pilot data will inform two future goals. First, it will inform the design of interactive digital activities in our Advanced Geometry course. Second, it will inform our future work on a larger study about overall engagement with various touchpoints (i.e., ways to participate) in fully asynchronous classes.

42. Thomas Freeman
Faculty Mentor: Dr. Chuck Higgins
Physics and Astronomy - Undergraduate

Analyzing Properties of Type II Solar Radio Bursts

Participants for Radio JOVE, a NASA partner citizen science project in solar and planetary radio astronomy, have observed many solar radio bursts during the current solar maximum. In particular, they observed many Type II solar radio bursts not commonly detected in the frequency range between 15 to 30 megahertz. Type II solar radio bursts are solar weather events often linked to shocks driven by coronal mass ejections (CMEs) and solar flares from the photosphere. They are characterized by their signature slow drift rates from higher to lower frequencies on a frequency-time spectrogram as the shocks travel farther away from the Sun. These drift rates reflect the plasma speed as they are ejected into space and can be used to measure fundamental properties of the emissions like shock speed and the magnitude of the magnetic field. Much research has been done on Type II radio bursts at frequencies above 40 MHz, however, many solar emission models are not as well-tested at frequencies below 30 MHz Radio JOVE observations can be used to extend the knowledge of solar emission properties to lower frequencies and, therefore, to distances farther from the Sun. Thus, this research can help us to better understand solar emissions and future space weather events.

43. Rhyan Helms
Faculty Mentor: Dr. Andrienne Friedli
Chemistry - Undergraduate

Stable Radical Derivatives with Pyridyls, Quinolines, and Isoquinolines

Blatter radicals (BR) are a class of 1,4-dihydrobenzo[e] [1,2,4] triazin-4-yl systems that exhibit high stability and have potential applications as magnetic or optoelectronic materials. Previously, BR derivatives containing an o, m, or para pyridyl at C-3 of the triazine were converted to Cu complexes to form single crystals suitable for single crystal X-ray diffraction (SCXRD) and solid-state magnetic studies. Here we report the formation of new pyridyl, quinolinyl, and isoquinolinyl ethers synthesized from the corresponding heterocyclic phenols using NaH in DMSO through a nucleophilic substitution at C8 in 8-fluoro-benzo[e]1,2,4-triazine. This work builds on recent reports of related quinolinyl and carbazolyl ethers that photocyclized through N1 to form the corresponding BRs. The photocyclization step was investigated for the new compounds in dichloromethane and ethyl acetate solvents and found to be most successful for 5-isoquinolinyl systems in ethyl acetate. Characterization of the intermediate ethers includes NMR, UV spectroscopy, and selected SCXRD structures.

44. Jacqueline Garrett
Faculty Mentor: Dr. Song Cui
Plant and Soil Science - Undergraduate

Forage Nutritive Value of Silphium integrifolium and Thinopyrum intermedium During the Establishment Year

Utilization of many perennial grain crops as both forage and grain crops is expanding rapidly across the US, driven by strong commercial and consumer demand from both the organic and conventional sectors. Silfower (Silphium integrifolium) and Kernza (Thinopyrum intermedium) offers excellent nutritive value in both seed (oil crop) and biomass (forage) compared to their annual counterparts, and even forage legumes. This study collected the establishment year forage biomass samples of both perennial grain crops based on a team-based class project and analyzed their nutritive value and mineral status. The results indicated average Relative Feed Value (RFV) of 341 and 170 of silflower and kernza, which is significantly higher than typical alfalfa RFV values at the pre-bud stage (near 164) and maturity (around 100). Our results also indicated much greater Crude Protein concentration (silfower, 30% and kernza, 34%) of both perennial grain species compared to alfalfa at the early cutting stage (16-20%). These results indicate extremely high nutritive value of perennial grain crops during the early growing stages. We expected similar trend remain as plants mature.

45. Patrick Ibrahim
Faculty Mentor: Dr. Kevin Bicker
Biology - Undergraduate

Investigating the Role of C. Neoformans Virulence Factors in Modulating Antifungal Peptoid Efficacy

Fungal infections such as those caused by Cryptococcus neoformans and Candida albicans have shown significant threats to immunocompromised patients, presenting high mortality rates, as well as showing high resistance to treatment options. Antimicrobial peptides (AMPs) have shown promising signs against these infections, however, due to high rates of resistance and AMPs' short half-lives, new therapeutic methods are needed to combat these infections. Peptoids, which are structurally very similar to peptides, but show higher signs of stability and resistance to these infections, show promising results. Specifically working with the peptoids RMG8-8 and RMG9-11 which have been created in the Bicker Lab have demonstrated successful antifungal activity against C. neoformans and C. albicans, however further work is needed to understand the full mechanism of these peptoids. With RMG8-8 showing promising results with C. neoformans and RMG9-11 with C. albicans, we will do further testing on how RMG8-8 disrupts fungal cells, through membrane disruption, by performing biochemical assays such as, capsular vs. acapsular studies, melanization assays, DNA gel shift, and live/dead DNA staining. Additionally, electron microscopy will be used to understand the morphological effect on fungal cells, all in hopes to understand the peptoids' antimicrobial properties, as well as provide us with possible pre-clinical treatments for these fungal infections.

46. Caleb Griffy
Faculty Mentor: Dr. Joshua Phillips
Computer Science - Masters

Geospatial Analysis of Accidents Involving Bicycles and Bicycle Route Locations in Chicago

Bicycle routes are designed to create a safe place for bike riders to use on the road. There has been a vast amount of previous research into traffic crash analysis, but focusing on bicycle routes and crashes involving bicycles has used basic methodology. In addition, data for cyclists who have not crashed has been historically hard to find concrete values for. Various methods have been proposed in an attempt to simulate this data. This project focuses on tackling both of these issues by using an Empirical Bayes estimate to predict the expected crash value at different locations in an example city, Chicago, and using average traffic speed over time to simulate cyclist traffic data. The difference between this expected value and the real count of crashes is used to identify hotspot locations for bicycle crashes. This experiment is repeated based on only crashes that take place on a bike route and only crashes that take place off a bike route. Using these results, maps are created to showcase locations where a bike route would be useful as well as locations where an existing bike route could be improved.

47. Mera Ishak
Faculty Mentor: Dr. Katy Hosbein
Biochemistry - Undergraduate

Investigating How General Chemistry and General Biology Students Define a Science Person and a Scientist

There have been several studies done on science identity and how it relates to student retention within the field of science. However, there persists the need for a more precise evaluation on how students define a "science person" and a "scientist." Knowing students' definitions of these terms will allow us to better understand how students view these roles, and in turn, provide us with the necessary information to develop learning environments that foster the development of a strong science identity. The chosen population of study is General Biology and General Chemistry students because these introductory science classes are what many researchers call the "gateway courses." This name comes from the idea that a student's experience in one of these courses dictates whether or not they continue their studies or career pursuits in the field of science. Student responses were gathered from a series of surveys created using the tool Qualtrics. These surveys included questions such as, "What is your definition of a science person?" and "What is your definition of a scientist?" Student responses were then coded using Descriptive Coding, which is a technique of coding qualitative data by summarizing into a few words or a short phrase. The results for this project will include how students define these two terms as well as the most prevalent codes or themes in student responses. This project will help inform educators interested in understanding student perceptions, giving them the means to encourage more inclusive definitions in order to allow students to see themselves within these roles and continue in their science majors.

48. Md Nahid Hasan
Faculty Mentor: Dr. Khem Poude
Computational and Data Science - Doctoral

Sleep Stage Detection by Leveraging Machine Learning Application

Sleep is an essential and universal behavior for physiological and mental well-being. More than 50 to 70 million Americans have sleep disorders (e.g., sleep apnea, insomnia). Sleep stage identification is vital for understanding sleep quality, diagnosing sleep disorders, and advancing personalized health monitoring. Early detection of sleep stages would be beneficial for national and personal well-being. We aim to develop an innovative artificial intelligence-driven sleep-stage framework from multimodal physiological data (ECG, SPO2, and EEG). We will use publicly available National Sleep Research Resource (NSRR) datasets to ensure generalizability across diverse populations. In particular, we will compute statistical features from the physiological responses. Then, we will use these statistical features in the machine learning classifiers and investigate how well sleep stages can be detected. Our proposed AI-based sleep stage identification could potentially help detect sleep quality and sleep disorders.

49. Abigail Kelly
Faculty Mentor: Dr. Arpan Sainju
Computational and Data Science

Comprehensive Livability Index using Road Network, Street View Images, and Socioeconomic Data

Quantifying the quality of life at a fine-grained neighborhood level is crucial for urban planning and policymaking. Existing livability indices often rely on coarse, city-wide data, overlooking local variations and spatial dependencies. This work presents a novel approach to mapping the livability index by integrating multimodal datasets, including Google Street View images, road network data, and various socioeconomic indicators. Our method models the road network as a graph, where nodes represent house locations enriched with visual and structural features derived from Street View imagery. These features capture environmental attributes such as road conditions, greenery, cleanliness, and aesthetics. A Graph Neural Network (GNN) is then employed to address spatial dependencies and generate neighborhood-level livability scores. The approach is tested on real-world datasets from Murfreesboro, TN. Preliminary results demonstrate the effectiveness of using street-level imagery for livability assessment, offering a more detailed and context-aware representation of urban quality of life. Future work includes optimizing the GNN architecture and expanding the dataset to diverse geographic regions. This research provides a scalable framework for policymakers and urban planners to make data-driven decisions for improving livability at a neighborhood level.

50. J. Hayes
Faculty Mentor: Dr. Elizabeth Barnes
Biology - Undergraduate

Exploring Christian Undergraduate Biology Students as Potential Boundary Spanners About Climate Change

Christian undergraduate biology students may have the potential to increase climate change acceptance within their religious communities, an important pursuit given the dangers of climate change to human health (Deng et al., 2020; WHO, 2021) and the strong predictive relationships between religious identities and climate change denial (PRRI, 2023). These students have the unique ability to act as boundary spanners, or individuals who bridge gaps between two groups by belonging to both (Williams, 2002). To accomplish this, these students need to accept climate change and effectively communicate about it with other Christians. However, we know little about these students' perceptions of or communication about climate change. Our research questions were A.) To what extent do Christian students accept climate change and perceive it as a risk, and how does this compare across non-religious Christian and non-religious affiliations? B.) How do students describe their own perceptions of climate change, and how do they communicate about it, if at all? To determine students' acceptance and risk perception, we surveyed 867 biology students at a university in the Southeast. We conducted semi-structured interviews with 20 Christian students who took our survey to further explore their perceptions of and communication about climate change. We found, using both quantitative statistical analyses and qualitative coding, support for these students' potential to be boundary spanners because they tend to accept climate change. However, their lower risk perception of climate change, infrequent communication, and use of ineffective communication strategies could be barriers to realizing that potential. Biology educators can use these findings about Christian student perspectives to include instruction that addresses them, possibly by showcasing climate change risks and hazards and highlighting effective communication strategies and students' potential for boundary spanning.

51. Lori Klukowski
Faculty Mentor: Dr. Ryan S. Jones
Mathematics and Science Education - Doctoral

Middle School Teachers' Questioning Strategies to Support Students' Sensemaking During Data Investigations

When students use and analyze data, they need to integrate quantitative reasoning, data science, and STEM content knowledge of the context (Kjelvic & Schultheis, 2019). Knowing how to support students' sensemaking of data, however, can be challenging for teachers (Elsayad et al., 2024). Teachers' questioning is one instructional strategy that plays a key role in supporting students' sensemaking. To support students' sensemaking, teachers must first anticipate student thinking and then use questioning to guide students to connect their own ideas with disciplinary content (Carpenter et al., 2020; Colley & Windschitl, 2016; Stein et al., 2008). Although guiding sensemaking through teacher questioning has been studied in science (e.g., Benedict-Chambers et al., 2017; Colley & Windschitl, 2016) and mathematics (e.g., Mueller et al., 2014; Stein et al., 2008), little is known about how teacher questioning strategies guide sensemaking during data investigations. To explore this gap, this project explores how experienced, in-service middle school science and mathematics teachers asked questions to support their students' sensemaking during data investigations.

52. Isaac Hollis
Faculty Mentor: Dr. Joshua Phillips
Computer Science - Masters

Dynamic Difficulty Adjustment Framework on Roblox

Dynamic Difficulty Adjustment (DDA) has been an active area of research in the gaming industry. Previous research has focused on deriving algorithms from Flow theory, and generic frameworks have been created to support DDA implementation. A DDA framework based on prior algorithms has not yet been created and tested on Roblox. Creating a generic framework on Roblox will advance research on DDA and validate proposed algorithms. To accomplish this, I will create the framework, create a prototype game, and then create a controlled study to test the framework's impact on player engagement. It is expected that player engagement will increase when the framework is implemented.

53. Lidya Kumar
Faculty Mentor: Dr. Anthony Newsome
Biochemistry - Undergraduate

Culture of Amoebae from Faucet Heads in Middle Tennessee Residence

Investigators have suggested that tap water can be a source of exposure and potential infection with what are now termed the “pathogenic free-living amoebae”. This refers to normally free-living amoebae that are prevalent in both water and soil yet also have the potential to cause disease in humans following exposure with the nose or eyes as serving as points of contact. Disease is not associated with the consumption of water. We investigated the potential of amoeba to reside in the faucet heads of residences and commercial facilities in middle Tennessee. The laboratory culture of amoeba from these sites suggested that amoeba cells were in domestic water and became a component of biofilms that can form in faucet heads. Results demonstrated that amoeba can be cultured from approximately 25% of sites tested. Amoebae are typically capable of multiplication at 37 C (body temperature) which supports potential to cause disease in humans. There is no clear standard methodology for eliminating the presence of these microbes in these habitats. Results do suggest, however, that precautions be in place to minimize exposure to entry into the nose and eyes. This is now a reason that tab water should not be used (unless boiled) for Neti Pots or used in conjunction with contact lens wear.

54. Vardhan Jalluri
Faculty Mentor: Dr. Khem Poudel
Computer Science - Masters

Edu Secure Data Management System

The project aims to create an Academic Information System (AIS) using a SQL Server database to securely manage educational institution operations. Key components include student and lecturer details, courses, and examination results. The system features Transparent Data Encryption (TDE), role-based access control (RBAC), column level encryption (CLE), and system versioned temporal tables. It also includes user authentication, encrypted password storage, secure data transfer, and comprehensive auditing of login attempts, data modifications, and permission changes. The design is secure with data encryption, data recovery, and detailed audit trails. The paper demonstrates how advanced SQL security features can be incorporated to create a reliable academic information system.

55. Jonathan Magdy
Faculty Mentor: Dr. Kevin Bicker
Biology - Undergraduate

Investigation into the Structure-Activity Relationship of Sarcosine Derivatives of an Antibacterial Peptoid

Staphylococcus aureus infections, specifically methicillin-resistant S. aureus (MRSA), are becoming increasingly drug resistant. This increase in drug resistance highlights the need for alternative antibacterial treatments. While peptides serve as our body's defense mechanism, they have short half-lives due to recognition by proteolytic enzymes. In contrast, antibacterial peptoids, peptide mimics with side chains attached to the amide nitrogen (N-substituted glycines) rather than the alpha-carbon, are resistant enzymatic degradation, giving them significant promise as novel therapeutic agents. MTL1-44, a peptoid discovered in the Bicker Lab, has shown promising levels of antibacterial activity against S. aureus while retaining low cytotoxicity. The focus of this project is on performing lead optimization of MTL1-44 via structural modifications to improve its antibacterial efficacy. Utilizing solid-phase synthesis, a sarcosine scan is being done to better understand the structure-activity relationship (SAR) within the peptoid.

56. Clifford Jones
Faculty Mentor: Dr. Don Hong
Computational and Data Science - Doctoral

K-Fold EWMA Chart Construction and Parallel-Computing Algorithms: A Theoretical Framework with Comparative Study of TEWMA and Standard EWMA

Exponentially weighted moving average (EWMA) charts are frequently employed in statistical process control, leveraging exponential decreasing weights on historical observations to detect shifts in the process mean. The triple exponentially weighted moving average (TEWMA) chart extends this approach by applying three sequential weightings to increase responsiveness. In this paper, a theorem (theorem$ 1$) is presented, offering a universal method for constructing chart statistics in the EWMA$^{\left(k\right) }$\textbf{\ }$\overline{X}$ chart framework. The theorem simplifies the multi-layer EWMA calculations and clarifies how these statistics evolve. Building on this theoretical basis, a parallel-processing simulation algorithm was developed to accommodate any EWMA$^{\left(k\right) }$\textbf{\ }$\overline{X}$ chart configuration efficiently across a wide range of parameters and shift magnitudes. A subsequent comparative study evaluated how effectively optimized EWMA and TEWMA charts minimize the out-of-control average run length (OOC ARL) under a fixed in-control average run length (IC ARL). Applied first to synthetic data and then to real-world annual flow volume measurements of the Nile River (1871–1930), the optimized EWMA chart consistently detected shifts more rapidly than its TEWMA counterpart, yielding shorter OOC ARLs and demonstrating greater robustness. These findings highlight the practical applicability of theorem in designing multi-layer EWMA charts and the advantages of the optimized EWMA approach for detecting process mean shifts.

57. Peter Malak
Faculty Mentor: Dr. Rebecca Seipelt
General Science, MSEAP - Undergraduate

The Effects of Total Dissolved Solids on Biodiversity Throughout the Stones River Watershed

The interdependence of our world not only applies to nations, economies, and individual lives, but also to the interactions between organisms and their natural environments (the ecosystem). Problematic actions or environmental changes affecting one group impacts many in an ecosystem. One environmental factor that impacts aquatic ecosystems is total dissolved solids (TDS; salts, minerals, metals, and other organic or inorganic matter). When TDS is high, aquatic life suffers, at least in part by destabilizing parts of that ecosystem such as food webs and reproduction. Therefore, we wanted to test this relationship of TDS and biodiversity in a local aquatic environment, the Stones River Watershed. We expected that higher TDS sites would have lower biodiversity based on the effects of TDS, particularly high salinity levels, on aquatic life. We collected water at eleven sites (twice) and determined TDS levels, as well as examined biodiversity using a combination of environmental DNA (eDNA) next generation sequencing, and bioinformatics tools. TDS ranged from 65 to 2.5 mg/L with most sites being below 30 mg/L. Alpha biodiversity (Inverse Simpson) ranged from 16.6 to 123.2, so most sites showed moderate to high diversity of species. When TDS was compared to biodiversity, we found no correlation (R2 = 0.0008). However, some inconsistencies in the data suggest the need for further study, including discordance of TDS and biodiversity levels from the two samples collected from the same site, which collected on different days, but also may have been collected from different parts of the river. Therefore, we plan to repeat this experiment with more controlled sample collecting requirements.

58. Pouyan Kalantari Mahmoudabadi
Faculty Mentor: Dr. Saeed Foroudastan
Engineering Management - Masters

Career Advantages of Business Education Courses for Science Master's Degree Students

MTSU and the College of Basic & Applied Sciences created the Master of Science in Professional Science (MSPS) program in 2004. Also known as a Professional Science Master's (PSM) degree, these interdisciplinary programs provide Middle Tennessee with the best-educated and well-trained scientific workforce. The Tennessee Board of Regents honored the MSPS program with its Academic Excellence Award in 2010. The program was also awarded the U.S. Department of Education's Graduate Assistance in Areas of National Need (GAANN) grant for Engineering Management in the fall of 2019. The program comprises core science classes, business management classes designed for science, math, and engineering students, and a capstone internship to gain real-world experience. In 2025, we examined numerous categories from the student's capstone internship evaluations from their employers during Spring 2015 through Fall 2024, including, but not limited to, Interpersonal Skills, Overall Performance, Quality of Work, Knowledge of Concentration, and Oral and Written Communication Skills.

59. Elena Mancera Andrade
Faculty Mentor: Dr. Kevin Bicker
Molecular Bioscience - Doctoral

Using the Peptoid Library Agar Diffusion (PLAD) Assay to Discover New Antimicrobial Peptoids Against Pseudomonas aeruginosa.

Peptidomimetics have emerged to mimic the structure and biological activity of peptides, which play key roles in physiological and biochemical processes. Specifically, peptidomimetic compounds like peptoids have been used as alternative therapeutic agents to overcome certain drawbacks associated with antimicrobial peptides, such as low bioavailability and limited diffusion into organs due to protease degradation. Peptoids, which are N-substituted glycine oligomers, differ from peptides in that their side chains are attached to the nitrogen-amide instead of the alpha-carbon, providing greater stability against proteases. The development of the submonomer approach and the one-bead-one-compound combinatorial library techniques have enabled the synthesis of many structurally diverse peptoids. However, traditional screening and optimization techniques for novel compounds are resource- and time-consuming. The objective of this project is to utilize the Peptoid Library Agar Diffusion (PLAD) assay, a high-throughput screening technique capable of testing thousands of compounds simultaneously, to discover antimicrobial compounds against Pseudomonas aeruginosa, an opportunistic multi-drug-resistant pathogen. This objective will be accomplished in three phases. Phase 1 involves designing and synthesizing combinatorial peptoid libraries to target the negatively charged membrane of P. aeruginosa. Phase 2 will consist of screening and selecting antimicrobial peptoids from the libraries. Finally, Phase 3 will involve characterizing the selectivity of the lead compounds toward the pathogen compared to mammalian cells based on quantitative assays. The results of each phase, along with promising peptoids, will be discussed.

60. Yousaf Khaliq
Faculty Mentor: Dr. Donglin Wang
Computational and Data Science - Doctoral

A Quantum-Enhanced Neural Network for Efficient Financial Market Prediction

In this study, we explore the application of quantum machine learning for predicting asset price, aiming to surpass the performance of traditional methods in both accuracy and computational efficiency. Using historical asset price data and market trading indicators, we implement a Quantum Long Short-Term Memory model to generate predictions for both Apple and Bitcoin daily and hourly price. Our findings reveal that the quantum model exhibits enhanced predictive results with lower root mean squared errors and mean absolute percentage errors than their classical counterparts, showcasing its potential to offer an advantage in the analysis of complex financial datasets. This research not only highlights the advantages of applying quantum computing to financial market predictions but also opens new avenues for investigation into the scalability of quantum machine learning and its applicability across various domains.

61. Shelby Mayhut
Faculty Mentor: Dr. Daniel Erenso
Physics and Astronomy - Undergraduate

AI-Assisted Spectral Profiling of Biomass-Derived Red Blood Cells for Stellar Research and Bioenergy

Previous studies, including our own, have shown that red blood cells derived from biomass waste can store and emit electromagnetic energy when exposed to infrared lasers and sunlight. To fully harness this ability, we are developing an AI-assisted program to construct a complete emission spectrum profile of ionized red blood cell samples, similar to the spectral profiles of stars. This program will analyze the illumination of radiation emissions from the ionized samples, identifying key spectral features such as wavelength, color, temperature, and intensity. The AI-assisted code breaks down the plasma's illumination into these spectral components by analyzing the light emitted at different wavelengths, which correspond to different colors and temperatures, and measuring the intensity of the emitted light. These features reveal how blood cells store and release energy from infrared laser light. By identifying and measuring these features, we aim to understand how red blood cell plasma stores and emits energy, potentially advancing stellar research simulations and utilizing biomass waste for renewable energy. This research employs AI-assisted code and modern physics laws to analyze video footage of red blood cells during laser ionization. By applying Stefan-Boltzmann’s and Wien’s displacement laws, we model the thermal radiation characteristics of ionized blood cells, breaking down the plasma's illumination into spectral components. Our current focus is on the computational analysis of the ionized blood sample’s emission spectrum to enhance our understanding of electromagnetic properties in biomass-derived red blood cells. The implications of this research are significant: it allows us to simulate hands-on research of a "small star," which could otherwise only be studied through observation. This contributes to advancements in renewable energy, medical diagnostics, interdisciplinary scientific discoveries, and environmental sustainability by better understanding how biomass waste stores and emits energy through spectral profiling.

62. Paul Klockenkemper
Faculty Mentor: Dr. Rachel Leander
Computational and Data Science - Doctoral

Modeling the Impact of Host Heterogeneity on the Risk and Dynamics of a West Nile Virus Epidemic

West Nile Virus (WNV) is a mosquito-borne arbovirus with significant ecological and public health implications. Its transmission cycle primarily involves avian hosts and mosquito vectors, with host diversity and mosquito population dynamics playing crucial roles in shaping epidemic patterns. In this study, we extend previous mathematical models by incorporating multiple host types, host demographics, horizontal transmission among hosts, and mosquito life cycle dynamics. Using a system of ordinary differential equations, we analyze the impact of host competence, mortality, abundance, and mosquito biting preference on WNV spread, while also considering differences between more urban and less urban settings. We derive an expression for the basic reproduction number in multi-host systems and demonstrate that increasing host diversity and demographic heterogeneity influence epidemic risk and persistence. Numerical simulations explore outbreak timing, magnitude, short-term and long-term dynamics, and possible steady-state behavior. Our findings underscore the importance of host heterogeneity, mosquito life cycle dynamics, and urbanization in WNV epidemiology, offering insights into optimizing targeted mosquito management strategies.

63. Zuhayra Mohamed
Faculty Mentor: Dr. Cole Easson
Biology - Undergraduate

Microbiome Shifts in Aplysina cauliformis Due to Ocean Acidification and Ocean Warming

The ocean's water is becoming warmer and more acidic due to increased carbon dioxide in the atmosphere. This rapid increase of carbon dioxide is deposited into the ocean through the atmospheric gas exchange, creating carbonic acid and increased hydrogen ion byproducts to lower pH and raise temperature. Together, these variables disrupt the marine ecosystem by throwing homeostasis off balance and damaging coral reefs. Our study was centered on Aplysina cauliformis, a common Caribbean sponge situated near the equator, rendering it more vulnerable to ocean acidification and warming. We investigated whether shifts in temperature and pH will disrupt the microbiome of A. cauliformis, and whether it will exacerbate the disease Aplysina Red Band Syndrome (ARBS), a highly transmissible disease spread through physical contact. We hypothesize that these stressors will have minimal effects on the microbiome of healthy sponges, but ARBS will likely lead to more impactful shifts within the symbiotic microbial community. To achieve this, DNA was extracted from samples exposed to various stressors, including health status (healthy or diseased), temperature (29°C or 31°C), and pH (acidic or nonacidic) in a factorially designed short-term stressor experiment. We conducted Illumina amplicon sequencing on the 16S rRNA region using standard universal primers. We analyzed our data using the statistical program R to determine the relative impact of our three stressors. Our initial results indicate a high impact of ARBS on the microbiome of A. cauliformis, while increased temperature and lower acidity led to more subtle shifts in the microbiome. Disruptions in microbiomes can lead to changes in the physiology of the overall sponge, which may broadly affect how A. cauliformis survives and interacts with other organisms on coral reefs.

64. Harshit Kumar
Faculty Mentor: Khem Poudel
Computer Science - Masters

Edu Secure Data Management System

The project aims to create an Academic Information System (AIS) using a SQL Server database to securely manage educational institution operations. Key components include student and lecturer details, courses, and examination results. The system features Transparent Data Encryption (TDE), role-based access control (RBAC), column level encryption (CLE), and system versioned temporal tables. It also includes user authentication, encrypted password storage, secure data transfer, and comprehensive auditing of login attempts, data modifications, and permission changes. The design is secure with data encryption, data recovery, and detailed audit trails. The paper demonstrates how advanced SQL security features can be incorporated to create a reliable academic information system.

65. Cassandra Mohr
Faculty Mentor: Dr. Sarah Bleiler-Baxter
Mathematics and Science Education - Post Doctoral Fellow

Catalyzing Departmental Change: A Literature Review of Barriers, Drivers, and Framing

Due to the pivotal role that academic departments play in influencing teaching quality in higher education, one natural entry point for enacting instructional change is to focus on departmental teaching culture as the unit of change. By identifying key factors that have the potential to impact the change process, specific departments, including undergraduate STEM departments, can leverage and fine-tune these factors to suit their individual needs. In this poster, we seek to answer the following question via an exploratory literature review: what are potential barriers and drivers to departmental teaching culture change and what strategies could be used to encourage embracement of departmental change? Emphasis will also be placed on highlighting potential implications of these findings with respect to implementation in undergraduate STEM departments. To answer our question, we conducted an exploratory analysis of literature via a keyword search of (departmental) cultural change. Identified barriers to change include: lack of professional knowledge, lack of time and resources, fear of the unknown, satisfaction with the status quo, lack of autonomy, and resistance to external leaders. Possible drivers for change are: lack of conflict between current values and the values associated with change, celebration of positive outcomes throughout the change process, reinforcement of change as an ongoing iterative process, a commitment to diversity and inclusion, and the leveraging of departmental leaders as agents of change. Finally, change should be framed as follows: change is at the departmental level, change is student centered, everyone is a collaborator in change efforts, change will have positive outcomes, and change efforts are data driven.

66. Ben Matthews
Faculty Mentor: Dr. Scott Handy
Chemistry - Masters

Monitoring Nickel-Catalyzed Allylation Reactions by UV/Vis and Fluorescence

In new reaction development, screening of several conditions and variables is essential, yet time consuming. While many options exist, in a project targeting carbonyl allylation using allylic alcohols or acetates, a rapid method was desired that enables reactions to be followed quantitatively over time. To accomplish this, a carbonyl was selected that exhibits either UV/Vis or fluorescence shifts as allylation proceeds. By removing small aliquots from reaction mixtures and measuring absorption intensity, a reaction's progress can be determined. Using this methodology has resulted in the reduction of both time spent and materials consumed, while simultaneously allowing for the collection of kinetics data on individual reactions.

67. Olivia Moreno
Faculty Mentor: Dr. Vincent Cobb
Biology - Undergraduate

Temporal Pattern of Foraging Activity in Leafcutter Ants: A 24-Hour Analysis in Costa Rican Forest

Leafcutter ants (Atta spp.) are important herbivores in the tropics and exhibit complex foraging behavior, which involves the collection of vegetation (mostly leaves) to serve as a growth substrate for their fungal food source inside their nest mound. In this study, we examined the temporal foraging activity of the leafcutter ant, Atta cephalotes, by recording the number of ants returning to their nest, carrying fragments of vegetation. Ant counts were conducted at two-hour intervals for a 24-hour period at La Selva Biological Research Station in Costa Rica in May 2024. Additionally, we quantified the vegetation fragments by type and size. Our goals were to describe the temporal foraging pattern and estimate the daily leaf area removed from the forest by an ant colony. Our results indicated a distinct diurnal pattern in ant foraging, with peak activity in the early morning and late afternoon. At night, low levels of activity were maintained with fewer ants entering the nest with or without vegetation. From one-minute counts every two hours, we extrapolated the data to a 24-hour period which resulted in an estimate of 135,200 ants entering the nest with vegetation. Leaves made up 92.2% of total material carried by ants. From a sample of 40 leaf fragments, we estimated the average leaf fragment size to be 1.385 cm2. This suggests that ants removed 18.7 m2 from the forest per day. These findings support the role of leafcutter ants serving as a major herbivore in the Costa Rican rainforest.

68. Gavin McGee
Faculty Mentor: Dr. Rachel Leander
Mathematics - Undergraduate

Modeling Mosquito Feeding Preferences

Mosquito feeding preference impacts the transmission of vector-borne diseases such as West Nile virus. Hence, mathematical modeling of mosquito feeding preference is important for understanding the risk and dynamics of vector-borne disease outbreaks. Mosquitoes exhibit two types of host selection, opportunistic and selective. In a study conducted on the mosquito species Culiseta melanura, it was found that this species will fly up to two km away to find hosts when mosquito population density was too high, which is an example of opportunistic feeding behavior (Verdonschot and Lototskaya 2014). Likewise, for selective feeding behavior, a study conducted in Yucatan, Mexico on Culex quinquefasciatus showed a large preference for avian hosts as compared to mammals by approximately ten times (Garcie et al. 2010). The use of a forage ratio, which is the ratio of blood meals taken from a certain host to that host's relative abundance, allows us to determine these relative preferences for mosquito feeding behaviors. It is difficult, however, to determine the forage ratio, as an accurate host density number is required. In this poster, we compare aspects of the model to empirical observations, as well as discuss the difficulties of parameterizing the model.

69. Ariel Nicastro
Faculty Mentor: Dr. Suman Neupane
Physics and Astronomy - Undergraduate

Improving Zinc Oxide Nanorod Synthesis for Enhanced Electrochemical Sensor Performance

Zinc oxide (ZnO) is a biocompatible inorganic semiconductor with light-emitting and semiconducting properties, making it suitable for diverse applications, including medicine, cosmetics, and nanotechnology. Its wide bandgap and high electron mobility make it particularly promising for advanced sensing technologies. This study focuses on optimizing the hydrothermal synthesis of ZnO nanorods by investigating the effects of autoclave temperature and surfactants. The goal is to produce nanorods with enhanced crystallinity, diameters below 50 nm, and large length-to-diameter ratios—key attributes for improved ZnO-modified sensor performance. X-ray diffraction confirmed the crystalline structure of the synthesized ZnO, while scanning and transmission electron microscopy characterized the nanorod morphology. UV-visible spectroscopy revealed strong absorption at 370 nm, corresponding to a 3.35 eV bandgap, validating the material's potential for sensor applications. The optimized ZnO nanorods are designed to enhance the sensitivity, accuracy, and scalability of ZnO-modified electrochemical sensors. Sensor performance will be assessed using cyclic voltammetry to track current responses to voltage changes. Future work will refine ZnO integration with electrode materials, explore alternative synthesis methods, and investigate the role of ZnO modification for biosensors and photoelectric sensors. By addressing critical synthesis challenges, this research advances the reliability and cost-effectiveness of ZnO-based sensors, paving the way for their broader use in environmental monitoring, healthcare, and industrial quality control.

70. Tejasri Nayudu
Faculty Mentor: Dr. Joshua Phillips
Computer Science - Masters

Secure AI-Based Biometric Authentication System

Biometric authentication has become a game changer in security, providing a far superior alternative to traditional passwords by leveraging unique physiological and behavioral traits like fingerprints, facial recognition, and voice patterns to improve accuracy, convenience, and protection against unauthorized access. But there are still some real challenges holding it back from being used everywhere—things like how well it works in different environments, people finding ways to trick the systems, and legitimate worries about keeping all that sensitive personal data safe and private. My project is to create a safe, AI-powered biometric authentication framework that improves accuracy, privacy protection, and resistance to harmful assaults. Integrating homomorphic encryption with secure multi-party computing protects sensitive biometric data throughout the authentication process. Our system employs CNN and RNN architectures to enable real-time liveness detection, effectively countering sophisticated threats like deepfake impersonation. The system's AI-driven adaptive thresholding adjusts to changing environmental conditions such as lighting variations, background noise, and device differences, ensuring consistent authentication performance in diverse real-world settings. Performance evaluation will utilize established datasets, including LFW, CASIA-FingerprintV5, and VoxCeleb, with a comprehensive analysis of FAR, FRR, and EER metrics to verify security and accuracy levels. I am also implementing blockchain-based logging to maintain data integrity and prevent unauthorized access. My aim is to build a system that stays accurate more than 95% of the time, even when conditions aren't ideal. It will be tougher against attacks and keep data safer through decentralized storage. What we learn will push forward cybersecurity research and real-world applications, showing how vital AI-powered biometric authentication is for protecting who we are online.

71. Samir Poudel
Faculty Mentor: Dr. Kritagya Upadhyay
Computational and Data Science - Doctoral

Federated Learning-Based Forest Scene Segmentation Using U-Net for Environmental Monitoring

Environmental monitoring is essential for assessing the impact of land use changes, climate variations, and human activities on ecosystems. This study focuses on forest scene segmentation using the U-Net architecture, leveraging a federated learning approach to enhance model generalization across diverse geographical regions while preserving data privacy. The model is trained on multi-temporal remote sensing data with ground truth annotations for validation. Experimental results demonstrate the effectiveness of the proposed approach, achieving a 93% Intersection over Union (IoU) and 98% accuracy. These findings highlight the potential of federated learning and deep learning-based segmentation for large-scale environmental monitoring, contributing to improved forest management and conservation strategies.

72. Emily Olson
Faculty Mentor: Dr. Daniel Erenso
Biochemistry & Physics - Undergraduate

Creation of Radiating Plasma from Silica, Blood, and Polystyrene beads Using Laser Trap, Sunlight, and Micromagnets

Polystyrene (found in styrofoam), silca, and bovine blood are common waste products in their respective industries. As such, finding alternative uses for these waste products is vital. In this project, we aim to use these products to create energy through blackbody radiation. This radiation is created through the use of an infrared laser trap that provides the energy to stimulate the radiation. Previously in the lab, we had success in the creation of ongoing blackbody radiation in a wide variety of animal blood, including horse, goat, and bovine. We are now interested in determining whether this blackbody radiation phenomenon will occur with other waste products. To do this, we have mixed silica beads, magnetic beads and bovine blood in a 50:4:5 ratio, which has displayed similarities to our solely blood based experiments. We also hope to see similar success using materials other than blood, so we have used polystyrene to observe the same phenomenon. For this, we have used a 200:1:10 water to magnetic bead to polystyrene ratio mixture and have successfully created small amounts of blackbody radiation. To increase the amount of radiation, we have now created a sample of 200:2:20 water to magnetic bead to polystyrene ratio, increasing the concentration of the polystyrene and thus the radiation. Our future goals are to create a laser trap using sunlight as its source, using solar radiation to create energy from these waste products.

73. Holly Powell
Faculty Mentor: Dr. Brittany Price
Geoscience - Undergraduate

The Mineral Composition and Paleo-Depositional Environment of Stone Door, Savage Gulf State Park, TN

Stone Door at Savage Gulf State Park in Beersheba Springs, Tennessee, is a massive geologic structure and an excellent example of sediment deposition in a shifting, near-shore environment. These Pennsylvanian-age clastic sedimentary rocks that cap the Cumberland Plateau were originally deposited by a river system similar to Amazonia that carried sediments eroded from the Appalachian Mountains (Davis, 2019) to the shallow continental sea that encompassed the interior of North America during this time. The “Stone Door” outcrop is a ~3-meter gap in the side of the Collins River Gulf near the Laurel Gulf Overlook and is composed of medium-to-fine-grained, Pennsylvanian-age conglomerates and sandstones (Fig. 1; Davis, 2019; Stuart and Roark, 2022). A better understanding of these environments is needed to further characterize these sandstone reservoir rocks and their significance in the formation of natural resources in Eastern Tennessee, such as coal and oil shales. The student’s goal is to identify the origin and mineralization of Stone Door, while honing their skills in mineral identification, depositional setting analysis, and provenance studies. This research aims to examine the evolution of near-shore depositional environments on the western flank of the southern Cumberland Plateau. Identification of changes in trace mineral composition will aid in understanding the provenance of these sediments as this river system evolved, while the stratigraphy indicates geologic changes in the paleo-environment, significant to natural resource development.

74. Delaney Reynolds
Faculty Mentor: Dr. Melissa Lobegeier
Environmental Science - Undergraduate

Identifying Lung Cancer Risk Areas in The Appalachian Region using GIS Technology

The Appalachian region of the United States has long been plagued by the coal business. While the region's economy largely relies on coal, the people have suffered. The presence of coal mines has led to extreme cases of water contamination and air pollution, as landscapes of the region are disrupted on a large scale. While environmental factors are certainly a leading cause of lung cancer, the region's high poverty levels and lack of healthcare have created a devastatingly high mortality rate for lung cancer. With the proper research and advocacy for healthcare resources, the Appalachian region can be better equipped to face the effects of open surface mining. Using GIS technology, the correlation between lung cancer mortality rates and coal mining can be better visualized. By mapping mortality rates for each county, hospital locations, and the locations of active coal mines, the relationship between these three variables can be better understood and identify areas at higher risk of lung cancer and visualize where healthcare resources can be placed to make the most difference. With the visualization of these three components, the Appalachian community will be able to get the care and attention it deserves.

75. Andrew Preston
Faculty Mentor: Dr. Joshua Phillips
Computer Science - Masters

Data-Driven Storage Format Selection for Sparse Matrix-Vector Multiplication

Sparse Matrix-Vector Multiplication (SpMV) is a critical operation in scientific and engineering applications, where performance depends on both the matrix’s properties and the storage format used. Selecting the optimal storage format is often left to a developer’s intuition, leading to suboptimal choices. This research systematically evaluates the performance of multiple storage formats across a diverse set of sparse matrices. Using the results, a decision tree model will be developed to predict the best storage format based on key matrix properties. The model will be trained on benchmark data and validated using a separate set of matrices to assess its predictive accuracy. By replacing intuition with a data-driven approach, this model provides a structured and empirical method for selecting storage formats. Developers can use its predictions to make informed decisions backed by research, ensuring optimal SpMV performance on consumer-grade hardware.

76. Grace Sandidge
Faculty Mentor: Dr. Mark Abolins
Geoscience - Undergraduate

Assessment of Sinkhole Flooding Conditions at Hooper Bottom in Murfreesboro, TN

In the Hooper Bottom focus area located in Murfreesboro, TN, sinkholes have been determined to be widespread (Bradley and Hileman, 2006). Recent observations of the March 28, 2021 storm event were made using Dove satellite images and ArcGIS, which allows for comparisons to be made with Bradley and Hileman's findings from their 2001-02 document. Similar to Abolins and Harris's (in press) conclusion on the Manson Pike focus area, we found that there has been little change in sinkhole flooding since 2001 despite the large-scale urban development that has occurred since then. Field site visits, satellite images, and delineated topographic depressions helped show that the main change in the past two decades is several sinkholes have been filled in and built over and a manmade retention basin held water after the storm. Based on this conclusion, we infer this may indicate overall effective stormwater management.

77. Prateek Rai
Faculty Mentor: Dr. Souvik Banerjee
Molecular Bioscience - Doctoral

Integrating Virtual Screening and Molecular Dynamics Simulations to Discover Autotaxin-LPA Signaling Axis Inhibitors for Synergistic Cancer Therapy

Therapeutic resistance is a major obstacle in cancer treatment, often leading to relapse and poor patient outcomes. Resistance to paclitaxel and other taxane-based therapies occurs in 30–70% of patients with advanced breast cancer and over 50% of ovarian cancer patients, significantly worsening prognosis and overall survival, emphasizing the urgent need for novel strategies to restore treatment efficacy. The autotaxin-lysophosphatidic acid (ATX-LPA) signaling axis drives therapeutic resistance by promoting cancer survival pathways. ATX hydrolyzes lysophosphatidylcholine (LPC) to produce LPA, which activates six G-protein-coupled receptors (LPAR1–6), regulating cell migration, proliferation, and motility, thereby facilitating metastasis and diminishing treatment efficacy. The ENPP2 gene, encoding ATX, has been identified among 90 drug-resistance genes, underscoring its significance as a therapeutic target. To address this challenge, we employed a hybrid structure-based and ligand-based drug design approach to identify novel inhibitors of the ATX-LPA axis. Virtual screening techniques, including 3D ligand-based similarity search, pharmacophore modeling, and molecular docking, were used to identify potential lead compounds from diverse chemical libraries. Molecular dynamics (MD) simulations provided deeper insights into the stability and binding mechanisms of these compounds, further guiding lead optimization. Among the top candidates, MolPort-137 and ATX-1d demonstrated potent ATX inhibition, with IC50 values of 1.6 ± 0.2 μM and 1.8 ± 0.3 μM, respectively. Binding free energy calculations confirmed their strong interactions with ATX, while in vitro assays revealed that these compounds synergized with paclitaxel to resensitize paclitaxel-resistant 4T1 murine breast carcinoma and A375 human melanoma cells, enhancing paclitaxel's efficacy by up to tenfold, without inducing cytotoxicity as standalone agents. These findings highlight the therapeutic potential of ATX-LPA axis inhibitors in overcoming cancer resistance. Moving forward, we will assess their synergistic effects with different chemotherapeutic agents, including tamoxifen, vincristine, doxorubicin, and sunitinib, across various malignancies to further establish their role in combination cancer therapies.

78. JoBeth Scarlett
Faculty Mentor: Dr. Alyssa Logan
Horse Science - Masters

Videos as a Form of Widespread Education from a Collegiate Equestrian Association

Growth and education are two concepts that go hand-in-hand when it comes to the horse industry. Especially in the Intercollegiate Horse Shows Association (IHSA), an ever-present discussion seems to find its way to the efforts of growth in the IHSA. The IHSA provides equestrian competition for college and university students across the nation, from beginner to advanced riders. The goal of this project is to create short videos addressing IHSA specific topics and provide supplemental information for members. In brainstorming for this project, multiple different topics were discussed, however it was agreed that the most beneficial topics would be (a) how to do a horsemanship bun, (b) how to do a hunt seat hair net for the equitation, (c) tips on preparing riders for a draw based system, (d) and tips for pattern layout and course design. Commonly, jumping into the unique system the IHSA is in can be a bit daunting for those that don't have a background in draw-based riding and competing. Barriers of understanding systems within IHSA may also prevent currently-competing teams from further advancement. By creating simple, informational videos that can address IHSA specific topics, quality information and education can continue to be accessible to a widespread audience. With the assistance of college partners, we were able to create 8 new videos to begin the development of this educational library. The videos are accessible to IHSA members and the general public through the IHSA YouTube channel and a future link being created for the Member Resources page on the IHSA website. These videos can be used by teams and riders to refine skills and assist in the continuing national growth of the collegiate equestrian industry.

79. Claudia Roselio Lafuente
Faculty Mentor: Dr. John Zamora
Biochemistry - Undergraduate

Affinity of Microorganisms to Dental Materials

Considering being healthy includes having good buccal health. The presence of cavities or different gum diseases are linked to heart and other health problems. The oral cavity is one of the areas in our body with the largest and most diverse microbiota. This includes bacteria, fungi, viruses, and even protozoans. It is typical and normal to replace part of our teeth or dental pieces with some kind of prosthodontics. In between the teeth, we have composite fillings (Resin), Silver fillings (amalgam, not used anymore), full metal crowns (Zirconium), implants, pure Porcelain, porcelain fused with metallic materials like cobalt-chrome, and plastic teeth. This project dealt with the ability of certain dental materials to affect the number of two different bacteria (Staphylococcus aureus and Escherichia coli). Antibacterial agents such as different mouthwashes and hydrogen peroxide were also evaluated to see if they affected the growth of these bacteria on the dental materials.

80. Veronica Seipel
Faculty Mentor: Dr. Kevin Bicker
Chemistry - Undergraduate

Synthesis and Analysis of Antifungal Peptoid Dendrimers

Fungal infections, particularly those caused by Cryptococcus neoformans, present a significant global health burden, with high mortality rates in immunocompromised populations. There are several antifungal treatment options available, but they exhibit high toxicity levels and drug-resistant variants of C. neoformans have become increasingly common. Peptoids, derivatives of peptides, offer a promising alternative due to their high antifungal activity, excellent half-life, low toxicity, and quick-killing kinetics. This study focuses on enhancing RMG8-8, a peptoid developed by our lab with high antifungal activity against C. neoformans, by synthesizing peptoid dendrimers to allow for more potent treatment options. Dendrimers are macromolecules with a unique branched structure that has been shown to improve drug efficacy by increasing the drug's half-life, solubility, and localized concentration. This presentation will show the results of the synthesis of peptoid dendrimers, accomplished through a mix of solid-phase synthesis and convergent synthesis. The resulting dendrimers are verified, characterized for their size, surface charge, and purity, and tested against C. neoformans using an MIC assay to determine antifungal properties.

81. Emma Rudesill
Faculty Mentor: Dr. Greggory McPherson
Physics and Astronomy - Undergraduate

Backscattering Interferometry and Applications

Backscattering interferometry is a topic of optics that involves a light source creating interference patterns that reflect these waves back to where they originated. This technique can be applied medically, theoretically, and experimentally to study topics such as changes in refractive index of a material and the behavior of molecules and other biological matter such as proteins. The purpose of this research is to develop and construct a backscattering interferometer and apply it to study the behavior of biological molecules under various conditions, as well as to measure changes in the index of refraction of materials for further analysis of these molecular interactions. This research consists of constructing a backscattering interferometer and collecting data to be analyzed.

82. Philip Sheffield
Faculty Mentor: Dr. Saeed Foroudastan
Engineering Management - Masters

Experimental Vehicles Program at MTSU

The Experimental Vehicles Program (EVP) is a student-led club that guides students through competing in three engineering-focused projects: NASA's Human Exploration Rover Challenge, SAE International's Baja Competition, and the Solar Splash Boat Race. Under Dr. Saeed Foroudastan's faculty support, students design, build, and test vehicles to compete in these events with schools around the world.

83. Alexander Rurik
Faculty Mentor: Dr. Donald Walker
Molecular Bioscience - Doctoral

Characterization of the Reptile and Amphibian Gut Micro- and Mycobiome; Discovery of Undescribed Basidiobolus Diversity

Herpetofauna (reptiles and amphibians) are among the most threatened vertebrate groups with approximately 21% of evaluated reptiles and 41% of amphibians threatened by extinction. The gut microbiome is a crucial element of herpetofauna conservation approaches, as dysbiosis in the microbiome may cause adverse health effects for the host. Understanding the dynamics of fungal-bacterial interactions in the gut microbiome can help to establish a baseline of knowledge to inform conservation strategies, however, relatively little work has been done to characterize the gut microbiomes of herpetofauna. Previous research has determined that filamentous fungi from the genus Basidiobolus are dominant members of the herpetofauna microbiome and its diversity shapes the bacterial community. By examining the bacterial and fungal assemblages in the herpetofauna gut across space, host phylogeny, and natural history, we aim to advance our understanding of the unique role that ubiquitous members like Basidiobolus play in the herpetofauna gut. We fill a knowledge gap by documenting and characterizing bacterial and fungal gut assemblages in the most phylogenetically diverse group of herpetofauna to date (150 species from 665 individuals), using high-throughput amplicon sequencing of 16S rRNA and ITS1 rDNA markers. Preliminary results suggest a strong signal of host phylogeny in predicting community structure of the bacteriome, but not mycobiome. Extensive undescribed diversity was documented within the genus Basidiobolus, with 136 unique OTUs identified compared to the 10 currently described species in this genus, accompanied by corresponding living isolates available for formal taxonomic description.

84. Nikhil Shrestha
Faculty Mentor: Dr. Matthew Klukowski
Biology - Undergraduate

Efficacy of Topical Administration for Acutely Elevating Corticosterone and its influence on Testosterone and Circulating Leukocytes in Male Eastern Fence Lizards (Sceloporus undulatus)

Studying the effects of the stress hormone corticosterone in reptiles is complicated because just capturing and handling reptiles can cause a very rapid increase in plasma corticosterone as well as rapid activation of the sympathetic nervous system. This problem could be circumvented by methods that allow researchers to manipulate levels of stress hormone without handling the animal. Thus, this study aims to determine the effectiveness of topical administration at elevating plasma corticosterone. Moreover, this research also investigates if an increase in plasma corticosterone would influence testosterone and leukocyte numbers in blood. Sixteen lizards were dividing into four groups: two control groups treated with sham oil and bled at 3 or 24 hours, and two experimental groups treated with topical corticosterone and bled at 3 or 24 hours respectively. Blood smears were performed to count the numbers of different leukocytes and ELISA assay was performed to measure steroid hormone concentrations. It was found that topical administration significantly elevated plasma corticosterone. However, no significant changes in testosterone or leukocyte numbers were observed. This study suggests that while topical corticosterone was a useful method to elevate plasma corticosterone in male eastern fence lizards, it does not seem to have acute effects on testosterone or circulating leukocyte numbers.

85. Derek Sanabria
Faculty Mentor: Dr. Andrienne Friedli
Biochemistry - Undergraduate

Trends in Reactivity of Azine Ligands with Cu(pdc)

Azine ligands can form mono- and bimetallic Cu complexes. These ligands are heterocycles containing an sp2-hybridized nitrogen. Cu complexes with azines are of interest for materials, bio-, catalysis, and magnetic applications. Pyridine, diazine, and triazine ligands were complexed with copper pyridine dicarboxylic acid, Cu(pdc). This precursor was pre-synthesized or formed in situ. Azine ligands were mixed with the Cu(pdc) complex in water, methanol, or a combination of water and methanol. The amount of methanol used was determined by the solubility of the ligand. Heat and slow cooling were most successful for yielding single crystals. Milder conditions at room temperature included layering methanol and water solutions, or the reaction of Cu(pdc) and ligand in methanol, followed by slow evaporation. Selected structures were characterized by single crystal X-ray diffraction and thermal gravimetric analysis. Comparison of results for synthesis of each complex and its X-ray structure determined relative reactivity of the azines.

86. Calle Shwani
Faculty Mentor: Dr. Kevin Downs
General Science - Undergraduate

Degradability of Sunn Hemp in the Bovine Rumen

Sunn Hemp, a legume, has a variety of nutritional properties that provide energy and proper fats for livestock. It is a crop that grows like hay and alfalfa, is cut, dried, and stored for feedings. In this study, we are taking a look at what percentage of Sunn Hemp is degradable in the fistulated rumen of a cow. This will be done using different incubation times and analyzing the samples of Sunn hemp after a week. The study will help farmers of America learn more about this crop that can be used as a cover crop for soil and be used as an excellent feed source for their livestock!

87. Derek Sanabria
Faculty Mentor: Dr. Andrienne Friedli
Biochemistry - Undergraduate

Synthesis of Potentially Bioactive Cu complexes

Chemical literature contains examples of mono- and bimetallic complexes of bioactive azines with copper pyridinedicarboxylic acid, Cu(pdc). Complexing Cu with amino acids and DNA bases with sp2 hybridized N can change the structural and potentially the DNA binding activity of such ligands. Here we report the attempted synthesis of new crystalline Cu complexes with these bioactive ligands. A reactive Cu complex, Cu(pdc) (H2O)3 was formed in situ or pre-synthesized. The ligands were mixed with the Cu complex in water, methanol, a combination of water and methanol, or by layering a solution of ligand and Cu precursor. Synthetic conditions were altered based on the solubility of the ligand and complex. Hydrothermal pressure conditions (90-110°C) and slow cooling were most successful in yielding single crystals. Crystal structures of Cu(pdc) azines were obtained by single crystal X-ray diffraction. Other methods for characterization of complexes included thermal gravimetric analysis.

88. Zaylan Spinner
Faculty Mentor: Dr. Rebecca Seipelt & Dr. Cole Easson
Animal Science - Undergraduate

Investigating the Impact of Total Alkalinity on Biodiversity in the Stones River Watershed

Biodiversity is critical for ecosystem health, and when disturbed by any number of events, the ecosystem and its inhabitants can suffer. One factor known to affect water ecosystems is total alkalinity, which acts as a buffer against pH changes. Aquatic species thrive only within a specific pH range and weather potentially dangerous pH fluctuations when alkalinity is moderate. When alkalinity is low many species are unable to tolerate the resulting rapid pH changes. To understand the possible impact of total alkalinity on biodiversity in the Stones River Watershed, water samples were collected at eleven sites in the fall of 2024 and tested for both total alkalinity and alpha biodiversity using environmental DNA (eDNA) to identify the eukaryotic species present. Interestingly, data from fall 2024 showed higher median biodiversity for lower alkalinity samplings (n = 14) and lower median biodiversity for higher alkalinity samplings (n = 8). When these data were compared to results from fall 2023 and fall 2022 in a scatterplot design, the negative correlation of alkalinity and alpha biodiversity were similar to fall 2023 but fall 2022 showed no correlation. Although we still need to perform statistical analysis on these data to ensure true differences. Still, these results are promising and suggest that total alkalinity, at least at these levels, is not negatively impacting Watershed aquatic life. In addition, alpha biodiversity levels appear to be increasing over the last three years showing a healthier trajectory for the Stones River Watershed. In future, we will continue to monitor water quality and biodiversity and are interested in using more detailed methods to measure alkalinity. Also, we would like to investigate a multi-factor model of alkalinity with other water quality measures to determine which combination of water quality attributes can best describe changes to alpha biodiversity in our local watershed.

89. Erin Scott
Faculty Mentor: Alyssa Logan
Horse Science, Equine Education - Masters

Creating New Competition Format for a Nationally Recognized Youth Equestrian Development Association

Testing and competition platforms provide an effective way to assess young equestrians' understanding of horsemanship skills they have gained through hands-on experience and formal instruction. For many young equestrians, showing is the primary method to showcase their abilities in the arena. However, success in the equine industry requires a combination of technical and soft skills that extend farther than just riding. Young equestrians begin developing skills through experiential learning opportunities, such as competitions or tests, often provided by organized groups. Recognizing the value of inspiring youth to develop a variety of skills, many associations implement various competition platforms, such as shows and tests, to inspire growth of the equine industry. Participants of these assessments are better prepared to pursue professional careers in the industry, as they gain valuable qualities during their preparation. These competitions help guide youth toward career goals, including higher education, advanced skill-building, and social networking within the equine industry. Recognizing that competitions are vital for youth development in the industry, this project partnered with the Youth Equestrian Development Association (YEDA); aiming to create a new competition format that highlights the importance of developing skills and knowledge out of the saddle. The new knowledge based competition features multiple styles of skill assessment, ensuring all types of learners can excel. The competition features sections such as horse judging, identification stations, and a written hippology exam. This competition was held at the 2024 YEDA National Championship held in Cleveland, TN, and was very well received with over 100 entries among four divisions. Due to the success of year one, the competition will return in 2025 and will feature a live horse judging portion that allows competitors to apply their knowledge of horsemanship across a variety of different classes.

90. Nick Stephens
Faculty Mentor: Dr. Donglin Wang
Data Science - Undergraduate

Using Data to Predict Secondary School Performance

This project aims to predict student academic performance using data collected from two public schools in Portugal during the 2005-2006 school year. Multiple machine learning models—including XGBoost, Generalized Additive Models (GAM), Random Forest, Support Vector Regression (SVR), and ensemble methods—are employed to analyze key factors influencing performance. The study evaluates model accuracy and feature importance to identify the most significant predictors of student success, providing insights that could inform educational strategies and interventions.

91. Dipesh Shrestha
Faculty Mentor: Dr. Arpan Sainju
Computational and Data Science - Doctoral

A Hybrid Deep Learning Framework for Alzheimer's Classification from Brain MRI

This work introduces a novel deep learning framework for classifying Alzheimer's disease using brain MRI scans. The proposed method unfolds each 3D MRI image layer by layer, starting from the outermost regions and moving inward. This process involves applying an attention mechanism on the six faces of each layer to extract discriminative spatial features. A dedicated 2D CNN processes each unfolded layer, and its output is concatenated with volumetric features extracted by a 3D CNN that captures the global context of the brain, forming the UFA3D model. Comparative experiments demonstrate that UFA3D outperforms a variant that applies unfolding with attention only (UFA) as well as a traditional multi-view, multi-slice approach enhanced with 3D CNN feature concatenation (MSA3D). Future work will explore enhancements using transformer architectures, contrastive learning, and advanced 3D histogram analysis techniques.

92. Bereket Tegistesillassie
Faculty Mentor: Dr. Vishwas Bedekar
Engineering Mechatronics - Undergraduate

Smart Navigation: How Different Algorithms Solve Mazes

This study compares the performance of four maze-solving algorithms—A*, Dijkstra’s, Flood Fill, and Recursive Depth-First Search (DFS)—for a micromouse robot. The goal of this research was to analyze the efficiencies of the four algorithms to determine which one can complete a random maze within the shortest amount of time, on average, over a set of trials. These tests were conducted with the aid of both digital simulations and physical time trials. The digital trials offer rapid testing for randomized mazes while the physical trials can assess real-world performance measures. Results demonstrated that A* consistently outperformed other algorithms in terms of speed and reliability. Along with the assessment of the maze-solving algorithms, this study also documented the design and construction of the physical mouse following along with the specifications of the National Robotics Competition. By analyzing the results from this study, a better understanding can be gained on autonomous robot navigation and contribute toward the future pathfinding strategies of autonomous systems.

93. Hannah Sisk
Faculty Mentor: Dr. Cole Easson
Biology - Undergraduate

Exploring Biogeographic Variation in Microbiome Communities of Sponges in the Western Atlantic

Members of the phylum Porifera are host to diverse and sometimes dense microbial symbiont communities. The relationship between sponges and their microbial symbionts is often key to their health and function in diverse environments, as well as their contributions to benthic communities. Sponge-microbe relationships are species-specific but have shown some variability within species across different environments. In the current study, we investigated geographic variability in the microbiomes of two sponge species, Aplysina cauliformis and Iotrochota birotulata. These two species are highly abundant on shallow reefs and adopt a rope-like morphology but contrast in microbial abundance. Samples were collected across 4 geographic regions within the Caribbean and Western Atlantic, and the microbiomes of each were sequenced using Illumina sequencing. Initial analysis showed clear differences in microbial communities between the two species. Each species varied across geographic regions, but patterns of divergence across regions for each species were different. Species composition varied across geographic regions, though the degree of variation differed between species. For Aplysina cauliformis, 25% of microbiome composition differences was due to collection location, while for Iotrochota birotulata, this increased to 35%. These trends in regional differences were driven by species-specific variations in microbiome taxa. These results suggest that although sponge microbiomes are species-specific, they also exhibit geographic variation that may be related to regional differences in environmental conditions.

94. Mary Tran
Faculty Mentor: Dr. Kevin Bicker
Molecular Bioscience - Doctoral

Structure-Activity Relationship Optimization of Antifungal Peptoids Targeting Candida albicans

The rising threat of antifungal resistance and the limited availability of effective treatments necessitate the development of novel therapeutic alternatives. Peptoids, N-alkylated peptidomimetics, have emerged as promising candidates due to their structural versatility, enhanced stability, and bioavailability. In this study, we employed a structure-activity relationship (SAR) approach to optimize the antifungal activity of peptoids, focusing on improving potency against Candida albicans while minimizing cytotoxicity. A total of 50 derivatives were synthesized through systematic modifications, exploring variations in side-chain composition, charge, hydrophobicity, and sequence orientation. Several derivatives exhibited enhanced antifungal activity, with five top-performing compounds demonstrating high selectivity ratios and potent efficacy against C. albicans. Among them, 911-M12 emerged as the most promising candidate, showing strong activity against multidrug-resistant C. albicans and C. auris. Our findings underscore the potential of SAR-driven peptoid design in antifungal drug development, providing a foundation for future preclinical evaluation.

95. Andrew Strick
Faculty Mentor: Dr. Katy Hosbein
Biochemistry - Undergraduate

An Analysis of Undergraduate Students' Perception of a 'Science Person' Throughout a Semester of Introductory Chemistry or Biology

Historically, STEM fields have shown a lack of equity, preventing marginalized students from pursuing and continuing education in STEM. One pathway for retaining marginalized groups in STEM is to foster the development of students' science identity which has been shown to increase the likelihood of continued education in a STEM-related field. While the various traits that students associate with a 'science person' have been explored, a more nuanced understanding of how students perceive a 'science person' can be achieved by analyzing these definitions throughout the progression of undergraduate STEM coursework. This study evaluated how definitions of a science person change over one semester for undergraduate students in general biology and chemistry. Open-ended survey responses collected at the beginning and end of the semester were analyzed using descriptive coding, compiling overarching themes into defined codes. Pre- and post-survey responses to the question What is your definition of a science person? were then coded and compared to assess shifts in perception. Trends observed detailing how perceptions of a science person changed throughout a semester with an emphasis on student identification with their responses will be shared within our findings. This will include an analysis of students' "stable" definition of a science person and individual responses that best encapsulate how the perception of a science person changes throughout a semester. The results of this project will help give instructors and students insight into how science identity can be better fostered in undergraduate courses.

96. Olivia Vickers
Faculty Mentor: Dr. Scott Handy
Chemistry - Undergraduate

Photocatalysis of Organic Reactions Using Crude St. John's Wort

Natural products, like hypericin, have gained significant interest as photocatalysts in organic synthesis. They effectively absorb light and offer a cost-effective and safer alternative to traditional metal photocatalysts based on ruthenium and iridium. Hypericin and its derivatives are naturally found, primarily in St. John's Wort, a readily grown plant that is a common commercially available nutritional supplement. Using pure, isolated hypericin is challenging since it is present in minimal amounts. One solution has been to bioengineer a microorganism to produce it. While successful, this method is technically difficult. We have opted to explore directly using St. John's Wort supplement capsules as the source of the photocatalyst and applied this to the reaction of an aryl diazonium salt with furan to form an arylated ring. St. John's Wort capsule is purified before adding it to the reaction to provide a cleaner result. The light sources used during each experiment include blue LED light, sunlight, and an 'everyday sun' lightbulb. Each experiment will be exposed to a light source for 48 hours. Various diazonium salts and aromatic rings are used as the starting materials for each photochemical reaction. The results of this research should highlight the potential for natural product mixtures to serve as effective and simple photocatalysts for organic reactions.

97. Rebecca Taylor
Faculty Mentor: Dr. Samuel Haruna
Forensic Science - Undergraduate

Nutrient Analysis of Soil under Row Crop and Perennial Management Systems

In Forensic Science, trace evidence is an important technique for comparing microscopic substances transferred between victims, suspects, objects, and places. Soil analysis is an important example of trace evidence because soil tends to attach itself to individuals or objects and be transferred from one location to another (or multiple other locations). Soil properties of interest in Forensic Science include soil pH, Soil Organic Carbon (SOC), Total Nitrogen (TN), particle size analysis, and soil nutrients (Calcium, Magnesium, Nitrate Nitrogen, Orthophosphate, and Potassium). In this study, these soil properties were compared between typical row crop management (tillage with no cover crop; TNC) and perennial systems (PER) (planted to fescue grass; Festuca). For this study, it is assumed that the average soil (without human remains) mimics the TNC management, while soils with remains would more closely mimic the perennial systems (due to more organic matter addition from plant roots). It is hypothesized that the soil under perennial management would contain higher amounts of nutrients due to the undisturbed turnover of plant biomass. Results showed that the soils under PER management was slightly more acidic compared with TNC management. As expected, SOC and TNC were higher in the PER compared with TNC management, probably due to C sequestration and N cycling. Nitrogen cycling also contributes to the levels of Nitrate Nitrogen because cover crops take up Nitrate during fallow (unused/ unsowed) periods to reduce use of Organic Nitrogen. This also allows for easier recycling of Nitrogen. Lastly, PER soil also had higher orthophosphate levels (often in particulate form), probably due to less soil movement and erosion under this management (PER) compared with TNC. Conclusively, results showed that forensic signatures can be evaluated based on certain soil nutrients and properties present in the environment.

98. Satish Wagle
Faculty Mentor: Dr. Khem Poudel
Computational and Data Science - Doctoral

Multimodal Anomaly Detection in Lung Disease Using Clinical Text and Imaging Data

Detection of extreme outlier or rare disease condition is necessary as it enables early diagnosis and intervention, enhancing patient outcomes. However, despite numerous studies, a comprehensive comparison of various machine learning and deep learning models, especially when applied to both unimodal and multimodal approaches still remain lacking. This research presents a comprehensive study of lung disease anomaly detection using various unsupervised learning algorithms and models. It aims to examine the performance of single mode approaches such as text analysis and image analysis and explores how the integration of these data types can enhance detection accuracy. This study leverages, a pre-trained Bio Clinical BERT model that takes charge of deriving the text embeddings from textual clinical descriptions, meanwhile pre-trained ResNet model is used for image embedding derivation from both frontal and lateral lung X-rays that will be merged into comprehensive image representations. Text and image embeddings are concatenated to finally generate high-dimensional multimodal embeddings. The anomaly detection is then performed on the unimodal; text and image, and multimodal embedding using unsupervised learning approaches; Isolation Forest, Auto-encoders and DBSCAN. The study expects, proposed multimodal framework would successfully capture rare patterns that represents the medical data hence greatly increasing the detection of rare lung conditions. Future line of work will involve using SHAP analysis for explainability to further validate the clinical relevance of the evaluated anomalies.

99. Qiya Wang
Faculty Mentor: Dr. Donglin Wang
Mathematics - Masters

Credit Default Data Analysis

This project investigates predictive modeling techniques to determine the likelihood of credit default using the "Bank Marketing" dataset from the UCI Machine Learning Repository. The primary focus is on analyzing the "default" variable, which represents whether a person defaults on credit. The dataset presents an imbalanced distribution, with a significantly lower proportion of positive (default) cases. The analysis begins with exploratory data analysis (EDA) to understand feature distributions, identify missing values, and assess correlations between variables. Data preprocessing is performed to encode categorical variables and address the class imbalance using the Synthetic Minority Over-sampling Technique (SMOTE). Five machine learning models—logistic regression, random forest, decision tree, XGBoost, and support vector machines (SVM)—are trained to predict credit default. Each model's performance is evaluated using metrics such as accuracy, F1 score, precision, recall, and area under the curve (AUC-ROC). Results are visualized using AUC-ROC curves to compare classification effectiveness across models. Preliminary results indicate that addressing class imbalance significantly improves model performance, particularly for recall and F1 score. Among the evaluated models, ensemble methods like XGBoost and random forest demonstrate higher predictive accuracy and robustness compared to simpler models like logistic regression. This project highlights the importance of tackling imbalanced datasets in financial decision-making and explores actionable insights for improving credit risk prediction. Future directions include hyperparameter tuning and incorporating additional features to further optimize model accuracy and reliability.

100. Cory Wang
Faculty Mentor: Dr. Sarah Bleiler-Baxter
Mathematics and Science Education - Doctoral

The Disconnect Between Undergraduate Standard Mathematics and Modern Applied Mathematics

Recent concerns highlight a shortage of engineering students to meet modern demands, in part due to the high drop-out rates in undergraduate engineering programs. Studies have attributed this to engineering students' struggles to transfer mathematical knowledge to engineering contexts. This concern is further highlighted by Chui and Jiang (2013), who described a recent shift in modern applied mathematics from modeling through differential equations to information processing and data science, requiring a different set of mathematical concepts not emphasized in the past, such as Fourier analysis and abstract linear algebra. This literature review aims to study the disconnect between the standard mathematics curriculum and modern applied mathematics. Due to the breadth of applied mathematics, I focus on integral transforms (Laplace and Fourier Transforms), which provide a bridge between the standard mathematics curriculum and modern applied mathematics. The following two research questions guide the review: How are the Laplace and Fourier Transforms viewed differently between mathematicians and engineers? Is the standard mathematics curriculum effective in preparing engineers for their future studies, particularly in the field of Fourier analysis? A search of mathematics education and engineering education journal articles and conference proceedings was performed with the keywords "Engineering Mathematics Education" and "Applied Mathematics Education". Articles not explicitly addressing differential equations, Fourier analysis, Fourier Transforms, or Laplace Transforms were excluded. Analysis of the literature revealed integral transforms are viewed differently between mathematics and engineering due to the question motivating integral transform usage in these contexts. In mathematics, transform methods are a tool to solve differential equations. In engineering, transform methods are the key to characterizing and analyzing linear systems without finding closed-form solutions. This results in key tasks, techniques, justifications, and theories involving the information processing dimension of mathematics being underdeveloped in undergraduate mathematics courses.

101. Erin Westerman
Faculty Mentor: Dr. Andrienne Friedli
Chemistry - Undergraduate

Demonstration of Environmentally Friendly Polymers

This demonstration for high school students was designed to introduce synthetic plastics and biodegradable polymers through discussion and an activity that illustrates formation of calcium alginate gel beads. Sodium alginate is a naturally occurring water soluble polymer derived from brown seaweed that is often used in food, drug delivery, and cosmetics. When exposed to calcium ions, sodium alginate forms cross-linked networks and forms semi-solid, biodegradable gel beads. The hands-on portion of the demonstration is a visual display of the polymer chemistry that forms the gels. Dyed sodium alginate will be pipetted into calcium chloride solution, and the resulting spheres will be removed. This activity will provide students with an accessible experience in polymer chemistry and opportunity to experiment with biodegradable polymers. The discussion will highlight differences in traditional and biodegradable packaging, specifically usage and potential for recycling. Students will be encouraged to consider the environmental impact of their own use and disposal of packaging materials in the context of the chemistry involved.

102. Derek Wiggins
Faculty Mentor: Dr. David E. Nelson
Molecular Bioscience - Doctoral

Cryptococcus neoformans Increases Host Macrophage Glycolytic Flux in an in vitro Pulmonary Infection Model

The environmentally ubiquitous basidiomycete, Cryptococcus neoformans (CN), is an opportunistic pathogen and the primary causative agent of cryptococcosis, a deadly pulmonary infection responsible for ~147,000 deaths annually. Infection begins when CN spores are inhaled into the lungs, where they are phagocytized by alveolar macrophages (AM). To successfully control the infection, these innate immune cells must mount a response that is sufficiently vigorous to eliminate the pathogen and yet temporally and spatially restricted to prevent tissue damage and inflammation that could impair lung function. To achieve this, AMs undergo transient repolarization to the highly microbicidal M1 state. As part of this phenotypic transition, most macrophage subtypes alter the balance of metabolic activity to favor glycolysis over mitochondrial respiration in a manner similar to the Warburg effect first described in cancer cells. However, the high oxygen/low glucose lung environment may not be conducive for this shift, and it is currently unknown whether AMs exhibit altered metabolic activity during CN infection. To investigate this, we utilized Fetal Liver-Derived Alveolar-like Macrophages (FLAMs), an AM model developed by the Olive Lab (Michigan State University), where fetal hepatic monocytes are differentiated into AMs by culturing with GM-CSF and TGF-β. Utilizing this system, we show that M1-polarized FLAMs infected with CN exhibit increased expression of glycolytic genes, resulting in a profound shift from the use of mitochondrial respiration as the primary mechanism of ATP production in naïve and M1 FLAMs to glycolysis by 24 h post-infection. Additionally, our data suggests that this change in metabolic flux is facilitated by increased HIF1 activity, a transcription factor known to regulate macrophage metabolism during hypoxia and microbial infection. These data support the continued study of CN infection on AM metabolism to further elucidate the mechanisms regulating this shift in ATP production and its impact on anti-fungal activity.

103. Ian Wilson
Faculty Mentor: Dr. Donald Walker
Biology - Undergraduate

The Snake Fungal Disease Pathogen Influences the Evolution of the Skin Microbiome

Identifying evolutionary and ecological influences on host-microbiome interactions and their role in host health may prove vital to determining effective means for targeted pathogen remediation and wildlife conservation. Exploring how bacterial-fungal interactions develop over time, within a host-microbiome-pathogen system, can be challenging given a lack of experimental control over environmental variation, host life history characteristics and time scale at which the microbes interact. By implementing a controlled experimental evolution design, we were able to characterize variation in bacterial fitness, colony morphology, and system relationships for two species of bacteria (Stenotrophomonas maltophilia and Chryseobacterium sp.) in response to metabolites produced by the snake fungal disease pathogen (Ophidiomyces ophidiicola). Strains of S. maltophilia and Chryseobacterium sp. were evolved on either a 10,000 ppm keratin control or a fungal spent keratin media. Using a fully factorial design, we passaged each strain independently and in coculture for ~90 generations, observing divergence in growth rates between both bacteria and media types, and survival in cocultures of S. maltophilia and Chryseobacterium sp. Our results will discuss mutation and growth rate variation for both in response to a fungal pathogen over time, and elucidate mechanisms of pathogen induced dysbiosis on the evolution of the microbiome. A deeper understanding of these microbial interactions within the snakeskin microbiome may prove critical for conservation efforts targeting populations threatened by snake fungal disease.

104. Sean Willis
Faculty Mentor: Dr. Cole Easson
Biology - Undergraduate

Temperature and Water Flow Effects on the Maturation of Freshwater Sponge Gemmules from Ephydatia Fluviatilis

This thesis aims to progress recent methodology for the hatching and development of freshwater sponge gemmules. Compelling research in recent years recognizes adult freshwater sponges as useful biotechnical tools for water quality monitoring and filtration. This research used sponges collected from the Elk River, TN, and refrigerated samples from the Easson lab. The choice species for research was Ephydatia fluviatilis. This species was chosen based on previous successful hatching trials. Water circulation and varying temperatures will likely influence the speed and probability of maturation.

105. Ahmeed Yinusa
Faculty Mentor: Dr. Misagh Faezinpour
Computational and Data Science - Doctoral

Enhancing Life Expectancy Prediction Through Machine Learning Models and Key Predictors

Life expectancy is a key indicator of a population's health and socioeconomic development. Traditional statistical models often fail to capture the complex, non-linear relationships between various demographic, health, and economic factors influencing life expectancy. Therefore, this study leverages machine learning techniques to enhance the accuracy of life expectancy prediction. Using a demographic, healthcare, and economic indicators dataset, we conducted a comprehensive comparative analysis of four models: Bayesian Ridge Regression, Random Forest, XGBoost, and Linear Regression. We performed extensive data preprocessing to ensure robust predictions, including handling missing values, feature scaling, and outlier treatment. We also evaluated the models' performances using Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R^2 Score. The results revealed that Random Forest outperformed all other models, achieving the lowest MAE (1.0522) and highest R^2 (0.9687), demonstrating its effectiveness in capturing complex dependencies. XGBoost followed closely, while Bayesian Ridge and Linear Regression exhibited lower predictive power due to their assumption of linearity. Feature importance analysis identified HIV/AIDS prevalence, Adult Mortality, Income Composition of Resources, and Schooling as the most influential factors in determining life expectancy. These findings highlight the crucial role of healthcare interventions, education, and economic policies in improving longevity. This study emphasizes the potential of machine learning-driven healthcare analytics to guide policy decisions and resource allocation.

106. Jacob Wolvington
Faculty Mentor: Dr. Charles Chusuei
Chemistry - Undergraduate

Dopamine Detection with a Prussian Blue Cobalt Oxide Carbon Nanotube Composite

Dopamine (DA) is used as a common neurotransmitter in the carotid part of the body, it helps organs respond to changes in blood O2 (hypoxia), CO2 (hypercapnia), and pH (acidosis). It is found in the brain, mammalian tissue, and bodily fluids. When dopamine appears as a hormone imbalance, it can be used as an indicator for disease markers. Several composites were made with Cobalt Oxide (Co3O4), COOH-Carbon Nanotubes (COOH-MWNTs), and Prussian Blue (PB), to identify the changes in concentration of DA. The addition of the Prussian Blue enhances the dopamine's signal. It enhances the signal in two ways by first disentangling the MWNTs, second it causes the Co3O4 particles to disperse, in turn minimizing aggregation. The composites were all mixed in a Phosphate Buffer Solution (PBS) at a set pH of 7.57. Different ratios of Co3O4 /MWNTs/PB were tested to see which would yield the most effective signal for DA detection. A 1:1 and a 1:2 ratio of Co3O4/MWNTs and PB were mixed for 5 and 6 hours in PBS. Cyclic Voltammetry (CV) and Linear Sweep Voltammetry (LSV) are used as the primary method for dopamine detection. Cyclic Voltammetry is set up as an electrochemical cell. We read the current changes from the oxidation peaks to measure the dopamine concentration. The concentration of dopamine in carotid body ranges from 1x10-3 – 1x10-1 M. Before the CVs were run, we prepared solutions of DA dissolved in PBS. We then purged those solutions with nitrogen gas.

107. Savea Zimmerman-Cameron
Faculty Mentor: Dr. Alyssa Logan
Equine Physiology - Masters

Nerve Blocking in Horses - A Pilot Study

Navicular syndrome is one of the most common causes of lameness in horses characterized by inflammation and degeneration of the navicular bone. Palmar digital neurectomy or "nerving" removes the sensation to the heel of the hoof and allows horses to compete without pain. Analgesia or "blocking" of the palmar digital nerves results in temporary loss of sensation. The purpose of this pilot study was to examine the effect of loss of sensation in the heel on forelimb area and force while tracking on various surfaces at the walk and trot. We hypothesized that soft ground would result in greater normal force and pressure distribution of the hoof and analgesia of palmar digital nerves would result in greater loading on all surfaces at the walk and trot. Three stock-type horses were fitted to Tekscan Hoof Sensors via glue-on shoes on the front hooves. Horses were randomly assigned the order for each test which included walking and trotting on hard and soft surfaces. Horses completed the same exercise pre and post-nerve blocking examining hoof normal force, loaded area, and stride duration. Results showed that ground and blocking status was significant for area ($P < 0.0001$), with post-blocking having greater loaded area than pre-blocking while tracking on hard ground ($P = 0.008$), but no difference on soft ground ($P = 0.94$). Similarly, ground and blocking status was significant for force ($P <0.0001$), with tracking on hard ground being greater post-blocking than pre-blocking ($P = 0.008$), but no difference on soft ground ($P = 0.20$). Stride duration was greater pre-blocking than post-blocking ($P = 0.0017$). Findings from this pilot study show that temporary blocking impacts forelimb loading and ground may be an important factor for horses with removed sensation to the heel. This provides support for further exploration into the long-term effects of nerving.

108. Monsour Zakariyah
Faculty Mentor: Dr. Katy Hosbein
Mathematics and Science Education - Doctoral

Faculty Perspectives on the Use of Learning Assistants (LAs) in Undergraduate Introductory Science Classes.

Previous studies have demonstrated that using Learning Assistants (LAs) in STEM courses with high DFW rates can raise student engagement, learning, and retention. Although studies support the benefits of LAs, implementing such evidence-based practices sometimes necessitates many changes from the instructors' point of view. This research study aims to investigate how instructors teaching introductory science courses introduce and use LAs in their courses. Specific research questions guiding this work are: (1) What are science instructors' experiences with LAs inside the classrooms? (2) What kind of support do science instructors perceive necessary to produce positive results in LA implementation? These issues will be addressed using qualitative research methods involving two instructors implementing the LAs in their introductory science classes. Data collection included monthly semi-structured interviews and in-class observations. Questions will help us to identify the instructor's perception of LAs, implementation difficulties, and the support they need. Results will reveal science instructors' experiences and core challenges while redesigning their teaching to use LAs to the best of their potential. Through the instructors' perspective, tailored resources can be developed to support the successful adoption and expansion of LA programs. The project could support evidence-based teaching and learning programs to improve student experience and retention.