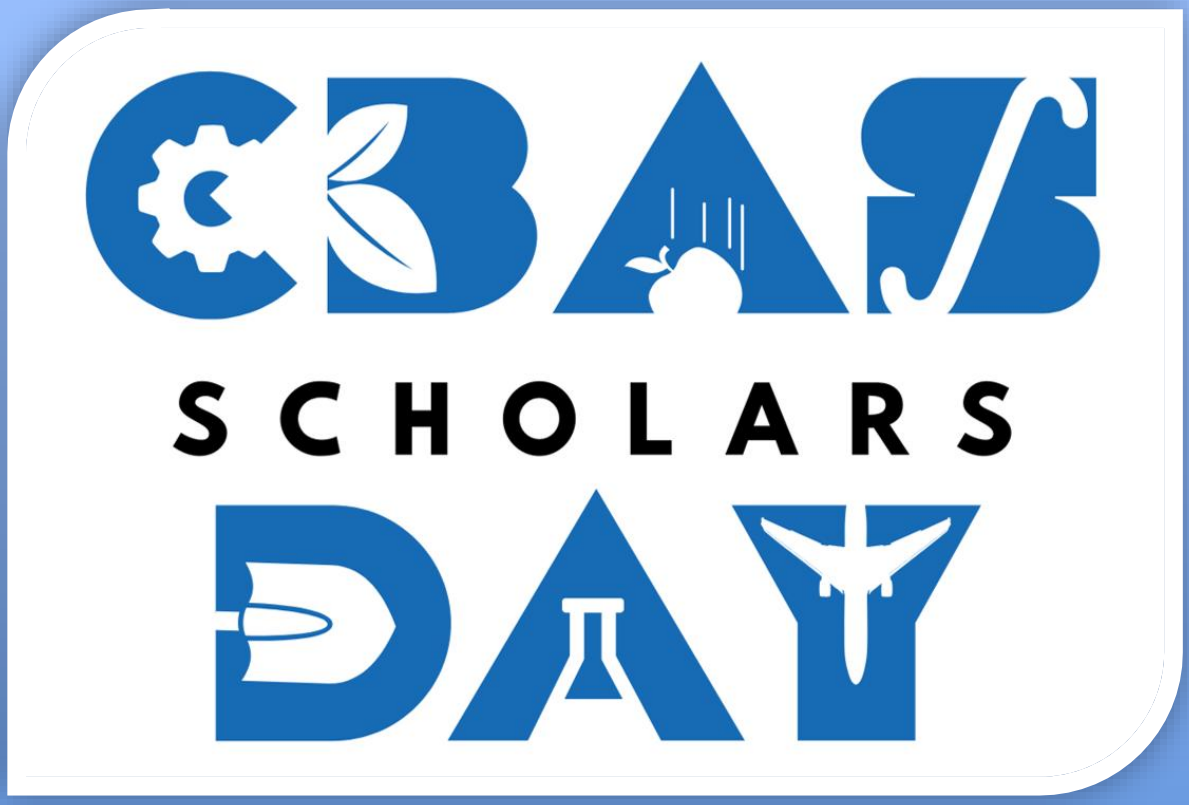

March 24, 2026

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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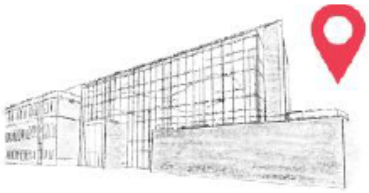
Event Schedule

CBAS SCHOLARS DAY

Event Schedule

March 24, 2026

Poster Competition



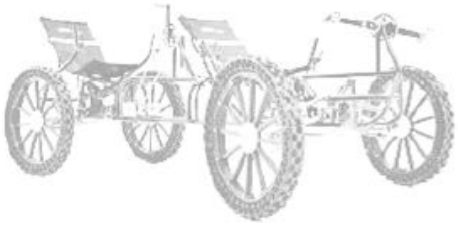
Science Building Atrium and Mezzanine
10:30 am – 1:00 pm

- Poster Session A: 10:30 – 11:45 am
- Poster Session B: 11:45 – 1:00 pm

Departmental Expo

Science Building Atrium and Outside
1:00 – 2:00 pm

Relax and have fun while learning more about the incredible departments in CBAS.



Raffle & Poster Competition Awards

Poster Competition participants have the chance to win raffle prizes and poster presentation awards.

Science Building Atrium
2:00 – 2:30 pm

Poster Presentation Listing

Poster Number	Name	Department	Faculty Mentor	Presentation Title
1	Bikram Adhikari	Computer Science	Dr. Joshua L Phillips	Empirical Evaluation of Machine Learning Models for DDoS Attack Detection Under Dataset Imbalance
2	Ariyo Adebiyi	Engineering Technology	Dr. Mina Mohebbi	Comparative Evaluation of Conventional and Emerging Techniques for Microplastic Removal from Drinking Water
3	Carly Altman	Agriculture	Dr. Chaney Mosley	Development and Content Validation of an Experiential Learning Instrument for Non-Formal Career Events
4	Rahmi Aini	Biology	Dr. M. Elizabeth Barnes	A Nature of Science-Grounded Framework for Diagnosing Students' Responses to Culturally Controversial Science Topics
5	Antony Atta	Biology	Dr. Mary Farone	omparative Infectivity and Host Range of "Candidatus Berkiella aquae" (HT-99) and "Candidatus Berkiella cookevillensis" (CC-99) in Amoeba, Insect, and Mammalian Cell Lines
6	Toyin Akinleye	Chemistry	Dr. Chengshan Wang	Determination of Conformation Change and Orientation of Specific Residues in the Oligomer of α-Syn(61－95) in Monolayer by p-Polarized Multiple Angle Incidence Resolution Spectrometry (pMAIRS)
7	Shaili Balampaki	Computer Science	Dr. Khem Poudel	Multimodal Fusion Strategies for Smart Contract Vulnerability Detection
8	Donye Asberry	Biology	Dr. M. Elizabeth Barnes	Undergraduate biology students experiences learning about human variation and development
9	Saroj Baral	Computer Science	Dr. Jorge Vargas	Curriculum Learning for Object Detection under Adverse Weather Conditions via Physics-Based Difficulty Estimation
10	Margarette Grace Bajar	Mathematics	Dr. Alyson Lischka	Experiences of Mathematics Anxious STEM Students
11	Dylan Beerman	Anthropology	Dr. Paul Emanovsky	Assessment of Photogrammetric Methods for Saw Mark Analysis
12	Gretchen Boeglin	Physics and Astronomy	Dr. Charles Higgins	Solar Intensity Compared to Solar Activity
13	Nyah Bentley	Engineering Technology	Dr. Hongbo Zhang	Development of an LCD Spatial Light Modulator and Exploration of Transport of Intensity Imaging
14	Amy Brown	Chemistry	Dr. Justin Miller	Effects of pH on the Biophysical Characteristics of Polymer Hydrolase PahZ1
15	Marissa Blair	Agriculture	Dr. Keely O'Brien	Valorization of Food and Beverage Waste for Production of Bacterial Cellulose from Kombucha SCOBY
16	Joey Buckingham	Physics and Astronomy	Dr. Daniel Erenso	The fidelity of quantum teleportation under a relativistic effect
17	Comfort Sarpong Boadu	Biology	Dr. Angela Google	Exploring Science Identity in Biology Education: A Systematic Literature Review
18	selah burton	Physics and Astronomy	Dr. Chuck Higgins	Statistics of Radio Jove Solar Observations

19	Yashoda Bogati	Agriculture	Dr. Keely OBrien	Development and Evaluation of Cellulose Kefiran Composite Films for Sustainable Dairy Food Packaging
20	Emily Callison	Biology	Dr. David Nelson	Investigating the Role of HIF-1 Induced Glycolytic Shift in Modulating Macrophage Anticryptococcal Activity
21	Christopher Bonnesen	Mathematics	Dr. Jeremy Strayer	Testing a Six-Dimensional Framework for How University Teachers and Students View the Nature of Mathematics
22	Alysa Chanthayom	Computer Science	Dr. Arthur Williams	Toward Autonomous Laboratories: Vision-Driven Robotic Decision-Making via Imitation Learning
23	Wendi Chen	Mathematics	Dr. Vijiara Manathunga	Aggregate versus Individual Loss Reserving: A Longitudinal Comparison for Growing Insurers
24	Kate Coscia	Biology	Dr. M. Elizabeth Barnes	Defining Undergraduate Science Communication Education: Emphasis, Evaluation, and Collaboration
25	Senthilraja Chinnaiah	Agriculture	Dr. Ying Gao	A New Root Rot Threat to American Ginseng: Identification and Biocontrol of Ilyonectria pseudodestructans
26	Johanna Crick	Biology	Dr. Donald Walker	Chryseobacterium and Stenotrophomonas as models to understand pathogen induced dysbiosis of the microbiome.
27	Gracie Choate	Biology	Dr. Cole G. Easson	Methods of Adhesion for Growing Eunapius Fragilis
28	Morgan Delaney	Agriculture	Dr. Alyssa Logan	Palmar digital perineural analgesia, as an experimental model for nerving in navicular disease, anticipated effects on forelimb loading in sound horses.
29	Christopher Clark	Chemistry	Dr. Souvik Banerjee	NOVEL COLCHICINE BINDING SITE INHIBITOR OVERCOMES TAXOL RESISTANCE IN METASTATIC MELANOMA IN VIVO VIA DUAL APOPTOSIS AND NECROPTOSIS PATHWAYS
30	Lydia Folorunsho	Chemistry	Dr. Souvik Banerjee	Design, synthesis, and biological evaluation of novel phenyl(quinoline) methanone-based colchicine-binding site inhibitors
31	Hampton Copeland	Chemistry	Dr. Anatoliy Volkov	Relativistic Dirac–Hartree–Fock X-ray scattering factors. III. Chemically relevant atomic anions
32	Mary Gendy	Chemistry	Dr. Kevin Bicker	Structure- Activity Relationship of
33	Lucas Davis	Chemistry	Dr. Sarah Bleiler-Baxter	Bridging the Gap Between STEM Teaching and Student Perspectives
34	Naime Beyza Gokce	Chemistry	Dr. Souvik Banerjee	Design, synthesis, and biological evaluation of novel imidazoquinoline-based colchicine-binding site inhibitors
35	Robert Davis	Chemistry	Dr. Kevin Bicker	Evaluation and Optimization of the Antibacterial and Cytotoxic Effects of Anti-Staphylococcus Peptoids
36	Ellaleigh Hall	Biology	Dr. Rebecca Seipalt-Theimann	Identifying Novel Phages in Local Environmental Sources for Potential Phage
37	Chloe Earls	Chemistry	Dr. Jan Halamek	Development of Field-Deployable Diagnostics for Biomedical, Forensic, and Security Applications
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40	Braedyn Hollingsworth	Chemistry	Dr. Souvik Banerjee	Novel Antimitotic Cancer Drug Synthesis: Triazoloquinazolininone-Based Colchicine Binding Site Inhibitors
41	rosalenda gendy	Chemistry	Dr. Jan Halamek	Endogenous Salivary Butyrylcholinesterase as a Biorecognition Element for Organophosphate Detection
42	Lexi Huff	Chemistry	Dr. Richard Nagorski	Effect of Metal-Dications on the Rate of the Aqueous Reaction of Benzyl Substituted N-(Hydroxybenzyl)benzamide
43	Marina Gerges	Computer Science	Dr. Joshua L. Phillips	Quantifying Background Dependence in Static ASL Alphabet Classification
44	Nicole Imbeault	Agriculture	Dr. Alyssa Logan	Glycemic and Insulinemic Responses of Horses to Abrupt Forage Type Switching
45	Heather Green	Biology	Dr. Grant Gardner	Departmental Supports and Barriers to Graduate Student Teaching Professional Development: An Interview Study
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51	J. Hayes	Biology	Dr. Liz Barnes	Barriers and Opportunities for Scaling Undergraduate Science Communication Education: An Autoethnography of Communication and Science Education Scholars
52	Alexis Katz	Biology	Dr. April Weissmiller	The Biological Evaluation of a Novel Set of Colchicine Binding Site Inhibitors Using A375 Melanoma Cancer Cells
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54	Emily Keiningham	Geosciences	Dr. Todd Moore	A Multivariate Spatial Analysis and Logistic Regression-Based Model of Hurricane Helene Landslide Induction Sites
55	Clifford Jones	Computer Science	Dr Khem Poudel	Mitigating the Privacy–Utility Paradox with Quantum Gradient Hiding
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57	Anna Kosinski	Agriculture	Dr. Anto Charles	Shiitake and Algal Proteins Mimicking Beef Fat through Emulsions
58	Ivan Lozano	Mathematics	Dr. Jeremy Strayer	Using LLMs in the Mathematics Classroom
59	Marci Leath	Agriculture	Dr. Alyssa Logan	Comparison of various sealing methods during one day of loaded testing with the Tekscan Hoof System
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61	Julie Lewis	Geosciences	Dr. Galina Shinkareva	Tracking Particles Through Time: How Sediment Size Relates to River Conditions
62	Julie Mehany	Biology	Dr. Robertson	Fusing the Two Subunits of Bacterial Luciferase into a Single-Gene Biological Reporter
63	Tomi Mafe	Chemistry	Dr. Kathryn Hosbein	Examining How Science Norms and Mentorship Shape First-Generation College Students' Motivation, Science Identity, and STEM Persistence
64	Mahmudun Noby	Chemistry	Dr. Chong	A Plasma-Based Remediation Strategy for PFAS and Co-Contaminants in Complex Matrices
65	Elena Mancera Andrade	Chemistry	Dr. Kevin Bicker	Using the Peptoid Library Agar Diffusion (PLAD) Assay to Discover New Antimicrobial Peptoids Against Pseudomonas aeruginosa.
66	Emily Olson	Chemistry	Dr. Hosbein and Dr. Phelps	Understanding Student Thought Processes in General Chemistry and Introductory Physics
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72	Travis Ray	Biology	Dr. M. Elizabeth Barnes	Are we Preparing Biology Students to Talk About Vaccines? Exploring Student Perspectives
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74	Eliana Rumberg	Biology	Dr. Cole Easson	Relationship Between the Antibiotic Resistance Gene SHV and Biodiversity in the Stones River Watersheds
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86	Isaac Smith	Chemistry	Dr. Souvik Banerjee	Design and Biochemical Evaluation of Novel Pyrazolo-Quinolin-5-One Derivatives as Potent Autotaxin Inhibitors to Overcome Chemotherapy Resistance
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90	Nada Srour	Computer Science	Dr. Joshua Phillips	Do Set Transformers Have Attention Sinks? High-Norm Token Analysis and Mitigation
91	Om Patel	Computer Science	Dr. Devin Jean	LLM Proposes, Coq Disposes: Quantitative Tactic Evaluation for Neural Theorem Proving in Rocq
92	Madelyn Sullivan	Biology	Dr. Michael Swanepoel	Effects of UV Radiation on the Alternative Splicing of the MCA2 Exon 8 gene
93	Samir Poudel	Computer Science	Dr Kritagya Upadhyay	SPA: Subspace Projection Aggregation for Privacy-Preserving Heterogeneous Federated Fine-Tuning of Large Language Model
94	Zaynab Syed	Biology	Dr. Megan Moore	Quantitative comparison of manual and AI-based segmentations of digital bone models using the 3D Slicer™ extension Total Segmentator
95	Maheswari Ramesh	Aerospace	Dr. Chaminda Prelis	Balancing Safety and Efficiency through Airport Operations and Project Management at Boise Airport
96	Avery Thomas	Chemistry	Dr. Andrienne Friedli	Charge transfer complexes of tetrameric Cu-based “tweezer” molecules

97	Ava Ruzzo	Chemistry	Dr. Jan Halamek	Atomic Absorption Spectroscopic Characterization of Bullet Alloy Ratios: Implications for Firearm Identification from Gunshot Residue on Bone and Other Impact Surfaces
98	Laurel Thompson	Chemistry	Dr. Sarah Pierce, Jesse Weatherly, Susan Martin, Susan Hanson	Poisoned Pages: Testing for Toxic Elements in 19th Century Book Bindings
99	Kathryn Serrano	Agriculture	Dr. Nathan Phillips	Germination behavior of Elaeagnus multiflora in response to seed freshness, stratification duration, and GA3
100	Caroline Tywater	Agriculture	Dr. Alyssa Logan	Online Education to Support Youth Judging Scores
101	Saya Shahoy	Biology	Dr. Angela Google	Supporting Cross-Cultural Mentorship Among Graduate Students Through an Asset-Mapping Tool
102	Cory Wang	Mathematics	Dr. Sarah Bleiler-Baxter	Asymmetric Matrix Analysis of STEM Departmental Social Network Structure
103	Kaijie Shi	Mathematics	Dr. Vajira Manathunga	Modeling Obesity-Driven Stroke Risk for LTC Insurance Valuation
104	Cory Wang	Mathematics	Dr. Sarah Bleiler-Baxter	The Tornado of Mathematical Knowledge: Revealing the Structure of Mathematics Through Contemporary Applied Mathematics
105	Maheswari Vaghela	Biology	Dr. April Weissmiller	Impact of WDR5 and G9a Inhibition on MYCN-Driven Neuroblastoma
106	Erin Westerman	Chemistry	Dr. Andrienne Friedli	Investigation of Photo-Smiles Rearrangement in Formation of 9- and 10-Substituted Planar Blatter Radicals
107	Catalina Valdivia	Agriculture	Dr. Caitlin Foley	Diagnosing Ketosis in Early Lactation Dairy Cows
108	Joshua Whitlock	Biology	Dr. Jeff Leblond	Galactolipids of the Terrestrial Dinoflagellate Rufusiella insignis: Comparison to Aquatic Dinoflagellates
109	Keira Warren	Biology	Dr. Andrienne Friedli	Investigating Host-Guest Interactions Between Tetrameric Copper Tweezers and Aromatic Fluorophores
110	Derek Wiggins	Biology	Dr. David Nelson	Cryptococcus neoformans Increases Host Macrophage Glycolytic Flux via HIF1 signaling in an in vitro Pulmonary Infection Model
111	Camryn Welborn	Physics and Astronomy	Dr. Chuck Higgins	Relating Type III Solar Bursts to Ionospheric Fadeouts
112	Ian Wilson	Biology	Dr. Donald Walker	The snake fungal disease pathogen (Ophidiomyces ophidiicola) influences the evolution of the skin microbiome
113	marjoni Williams	Biology	Dr. Danielle D. Brown	Waiting to Feed: Interspecies Dynamics and Feeding Latency at Deer Carcasses in Black and Turkey Vultures

114	Anelise Wilson	Agriculture	Dr. Alyssa Logan	A look at how changes in soil alter arena surface factors
115	Gavin Wilson	Aerospace	Dr. Andrea Georgiou.	Examining the Usefulness of AI for Flight School Safety.
116	Michaela Winslow	Agriculture	Dr. Alyssa Logan	Development of Open Access Educational Videos for Ranch Horse Competitors
117	Meleia Wolvington	Chemistry	Dr. Ngee Sing Chong	Analysis of landfill contaminants in air, water, and soil samples
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119	jacob wolvington	Chemistry	Dr. Charles Chusiue	Glutathione Detection via “Turn-on / Turn-off” Mechanism with Black Carbon Dots and Cu(II) Ions
120	Madison Yahn	Biology	Dr. Elliot Altman	Bioinformatic Characterization of Mutations Associated with Enhanced Acetate Metabolism in Escherichia coli
121	Patrick Wong	Physics and Astronomy	Dr. Hanna Terletska	Developing quantum embedding cluster approaches to study disorder effects in quantum materials
122	Monsour Zakariyah	Chemistry	Dr. Katy Hosbein	From Content Coverage to Structured Engagement: Faculty Instructional Change in LA-Supported STEM Courses.

Abstracts

March 24, 2026
Technical Program

Poster 1: Empirical Evaluation of Machine Learning Models for DDoS Attack Detection Under Dataset Imbalance

Presenter: Bikram Adhikari
Major: Computer Science
Department: Computer Science
Faculty Mentor: Joshua L Phillips

Abstract:

DDoS attacks continue to be a serious threat to networked systems, and machine learning has become a widely explored solution for building intrusion detection systems capable of catching these attacks in real time. Despite high accuracy numbers reported in existing studies, comparisons across work are difficult to make -datasets differ, preprocessing steps are inconsistent, and class imbalance is often handled poorly or even ignored entirely. When a dataset is heavily skewed toward normal traffic, overall accuracy becomes a misleading metric that hides how badly a model actually performs on attack traffic, and classifiers risk learning artificial dataset patterns rather than true attack behaviors.
This study pursues two specific aims using the CICIDS2017 dataset, which reflects realistic and highly imbalanced modern network traffic. The first aim evaluates Random Forest, Support Vector Machine, and k-Nearest Neighbors classifiers trained on an 80/20 stratified split, assessed using precision, recall, F1-score, and confusion matrices to establish a baseline comparison of flow-based DDoS detection models. The second aim investigates how preprocessing decisions -specifically mutual information-based feature selection and class balancing through SMOTE and undersampling - influence detection performance by directly comparing results before and after their application.
Random Forest is expected to outperform the other classifiers given how well ensemble methods handle the high-dimensional and nonlinear nature of network traffic data. For the second aim, we anticipate that dataset balancing will substantially improve recall specifically for minority DDoS attack classes, even where overall accuracy shifts minimally - a distinction that matters far more in real detection scenarios than aggregate accuracy alone.
These findings highlight that preprocessing and class imbalance handling are just as critical as model selection when building reliable intrusion detection systems. Unlike studies that evaluate models or preprocessing in isolation, this work examines both together while keeping the focus on what actually matters in real detection whether the attack gets caught, not just whether overall accuracy looks good on paper.

Poster 2: Comparative Evaluation of Conventional and Emerging Techniques for Microplastic Removal from Drinking Water

Presenter: Ariyo Adebiyi
Major: Engineering Technology
Department: Engineering Technology
Faculty Mentor: Mina Mohebbi

Abstract:

The rapid rise in plastic production and its widespread use across industries has led to widespread microplastic (> 5mm particles) contamination of aquatic environments. These particles are now commonly detected in streams, recreational waters, drinking water, and tap water, raising serious environmental and public health concerns. Because most plastics are non-biodegradable, they persist in aquatic systems for long periods, threatening marine life and potentially entering human food and water supplies. In response, numerous removal techniques have been developed and tested at both laboratory and industrial scales. These include physical approaches such as sedimentation, filtration, adsorption, and membrane technologies, as well as chemical and physicochemical processes like coagulation–flocculation, magnetic nanoparticle separation, and advanced oxidation treatments. Although many of these methods demonstrate measurable effectiveness, each has limitations related to cost, efficiency, operational complexity, or scalability. As a result, no single technique has yet emerged as a universally accepted global standard for microplastic removal. The purpose of this study is therefore to critically review existing and emerging removal technologies and identify those with the greatest potential to become standardized, repeatable solutions requiring minimal additional development. Attention is given to methods capable of meeting regulatory expectations comparable to those of environmental protection authorities (e.g., US EPA) for treating drinking water, tap water, and recreational water sources. Evaluation criteria include removal efficiency, affordability, ease of operation, safety, and the availability of required materials and equipment. By comparing these factors, the study aims to highlight the most practical and scalable strategies for effective microplastic remediation, thereby advancing reliable water treatment technologies and supporting global efforts to protect aquatic ecosystems and human health.

Poster 3: Development and Content Validation of an Experiential Learning Instrument for Non-Formal Career Events

Presenter: Carly Altman
Major: Mathematics and Science Education
Department: Agriculture
Faculty Mentor: Chaney Mosley

Abstract:

This study focused on the development and content validation of survey items aligned with Kolb's experiential learning theory (ELT) to measure experiential learning in non-formal career events. Because limited instruments exist that specifically assess the four stages of ELT (Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation), survey items were developed to evaluate each stage within the context of post-secondary students' career engagement. To establish content validity quantitatively, researchers implemented the methodology by Lawshe (1975) by using an expert panel to evaluate each survey item and rate each statement. The expert panel individually evaluated each statement as essential, useful but not essential or not necessary. Based on the expert panel size a minimum content validity ratio threshold was required for item retention in the survey. The items retained were then used to calculate the content validity index for survey items that needed refinement. Qualitative feedback from the panelists informed the refinements to improve clarity and theoretical alignment to ELT. The results of the CVR and CVR established quantitative content validity and support the instrument development by explicitly describing the process. The research provides a more rigorous measurement of content validity than qualitative methods and offers a theoretically grounded measurement of experiential learning for career events.

Poster 4: A Nature of Science-Grounded Framework for Diagnosing Students' Responses to Culturally Controversial Science Topics

Presenter: Rahmi Aini
Major: Mathematics and Science Education
Department: Biology
Faculty Mentor: M. Elizabeth Barnes

Abstract:

Evolution is a core content in undergraduate biology, yet many students still view it as controversial due to perceived conflict with religion and a limited understanding of the Nature of Science (NOS). NOS is often integrated into biology instruction, so students can learn both scientific content and how scientific knowledge is developed, justified, and revised. However, prior work in science education research has mostly focusing on defining NOS and how to teach it, rather than using NOS as a framework for assessing students' attitudes toward culturally controversial science topics.
This project introduces a novel NOS-grounded framework that can be used to diagnose where students struggle with evolution, such as scientific knowledge claims, scientific evidence and practice, or epistemological conflict. This framework offers a more precise way to examine students' responses to controversial topics in biology by identifying where the challenge is located. For example, students may reject evolution as scientific knowledge (product), misunderstand how evidence and scientific inquiry support evolutionary explanations (practice), or perceive evolution as incompatible with their prior beliefs (way of knowing). This framework may support more meaningful and culturally competent biology teaching by helping instructors identify whether students' challenges reflect questions about scientific knowledge, scientific practice, or perceived worldview conflict, rather than treating all responses as the same kind of cognitive limitation.

Poster 5: omparative Infectivity and Host Range of “Candidatus Berkiella aquae” (HT-99) and “Candidatus Berkiella cookevillensis” (CC-99) in Amoeba, Insect, and Mammalian Cell Lines

Presenter: Antony Atta
Major: Biology
Department: Biology
Faculty Mentor: Mary Farone
Co-Presenters: Abanoub Sayed Saleh

Abstract:

Obligate intracellular bacteria are completely dependent on eukaryotic host cells for survival and replication, and often have environmental amoebae as reservoirs that help in adapting to more complex hosts. “Candidatus Berkiella aquae” (HT99) and “Candidatus Berkiella cookevillensis” (CC99) are two closely related bacteria that have been found to replicate in the nuclei of Acanthamoeba polyphaga. Although CC99 has been found to infect amoebae and mammalian cells, HT99 was thought to infect only amoebae cells. However, due to their genetic similarity to Coxiella burnetii, a pathogen transmitted by arthropods, we tested whether insect cells could act as intermediate hosts to increase the infective potential of these bacteria.

Infection was done using lysates of infected A. polyphaga cultures at a multiplicity of infection (MOI) of 100-200 on Sf9 insect cells. Infection was then carried out in mammalian THP-1 macrophage-like cells and A549 lung epithelial cells. Infection efficiency, intracellular localization (cytoplasmic vs. nuclear), and replication were determined by Giemsa staining and quantitative PCR (qPCR).

Results show that both HT99 and CC99 successfully infect and replicate in Sf9 insect cells, thereby increasing the host range of HT99 beyond amoebae. However, only CC99 could establish productive infection in mammalian cell lines, while HT99 remained restricted to amoebae and insect cells. Microscopic observations showed typical vacuolar and intranuclear localization patterns typical of active intracellular replication.

These results provide evidence for the hypothesis that insect cells may act as evolutionary intermediates between environmental amoebae and mammalian hosts. Differences in temperature sensitivity, host receptor affinity, or metabolic requirements may account for the observed divergence in host range between HT99 and CC99. Current comparative genomic studies are underway to identify genetic factors that may be responsible for host specificity and to further clarify the mechanisms underlying the adaptation of environmental bacteria to mammalian infectivity.

Poster 6: Determination of Conformation Change and Orientation of Specific Residues in the Oligomer of α-Syn(61—95) in Monolayer by p-Polarized Multiple Angle Incidence Resolution Spectrometry (pMAIRS)

Presenter: Toyin Akinleye
Major: Molecular Bioscience
Department: Chemistry
Faculty Mentor: Dr. Chengshan Wang
Co-Presenters: Oluwasina Fabusiwa

Abstract:

α-Synuclein (α-syn) is a membrane protein made up of 140 amino acids, and its abnormal aggregates is the major protein component of Lewy bodies, which is the hallmark of Parkinson's disease (PD). α-syn accumulates in the presynaptic terminals in neuronal cells, where high concentrations of phospholipid bilayer structures (such as vesicles) exist as a monolayer structure at the amphiphilic interface. α-Syn in monolayer structure and conformation change cannot be addressed with high resolution by major techniques (i.e., X-ray crystallography, NMR, and cryo-Electron Microscopy). Notably, the structure of the early-stage aggregates (oligomers) of α-syn remains unknown. Whereas, p-polarized Multiple Incidence Angle Resolution Spectrometry (pMAIRS), as a recently developed surface FT-IR technique, has been shown to be able to provide helpful information about both conformation and orientation of peptides/proteins in monolayer structure. A critical segment of the α-syn protein spanning residues 61-95, known as the Non-amyloid Component (NAC) region (α-syn(61-95)), is highly prone to aggregation, and also aggregates with Aβ peptide found in senile plaques in Alzheimer's disease (AD). Therefore, the conformation change of α-syn(61-95) monolayer is highly relevant to both PD and AD. Here, pMAIRS was used to investigate the α-syn(61-95) monolayer formed at the interface after compression for various times. α-Syn(61-95) oligomers were formed after three days of compression, with conformational changes occurring in some residues of α-syn(61-95) from α-helix to β-sheet. When 13C label was introduced to the backbone carbonyl, C-terminus residues such as 93G retained the α-helix conformation after three days of compression, while residue 68G in the N-terminus was found to be involved in conformation change, with the backbone carbonyls forming β-sheet conformation perpendicular to the interface. In general, pMAIRS was able to address both conformation and orientation of specific residues in α-syn(61-95) monolayer, even for its oligomeric aggregates formed at the early stage

Poster 7: Multimodal Fusion Strategies for Smart Contract Vulnerability Detection

Presenter: Shaili Balampaki
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Dr. Khem Poudel

Abstract:

Smart contracts are central to blockchain ecosystems, yet vulnerabilities in deployed contracts pose significant security and financial risks. While traditional analysis tools and recent deep learning models have improved detection, many approaches rely on a single contract representation and may overlook complementary semantic, structural, and execution-level signals.
This project proposes a multimodal transformer framework for smart contract vulnerability detection that integrates five modalities: source code, bytecode, opcode, intermediate representation, and control-flow graphs. We systematically evaluate four fusion strategies concatenation, cross-attention, interleaving, and gated fusion under a unified experimental protocol to determine the most effective architectural design. Although experimental results are not yet available, we predict that combining complementary modalities through optimized fusion will achieve strong improvements in detection accuracy compared to unimodal baselines. We aim to achieve a performance of 85% or higher with this proposed architecture. This work aims to provide empirical guidance for designing robust AI-driven smart contract security systems.

Poster 8: Undergraduate biology students experiences learning about human variation and development

Presenter: Donye Asberry
Major: Biochemistry
Department: Biology
Faculty Mentor: Liz Barnes

Abstract:

Evolution and genetics are central to biology education and can clarify misconceptions about race by emphasizing shared human ancestry and genetic similarity. Although scientists recognize race as a social and cultural construct rather than a biological category, students may continue to interpret race as genetically determined. Avoiding explicit discussions of race in biology courses may unintentionally reinforce these misconceptions. Despite the importance of this topic, little research has examined how undergraduate biology students experience learning about race at the intersection of evolution, genetics, and culture.

This study explored undergraduate biology students' perceptions, learning experiences, and communication about race. We conducted semi-structured interviews with six undergraduate students who had previously completed a survey on evolution and science communication. Interviews focused on how students define race, how they learned about race and evolution in biology courses, and how they communicate about race outside the classroom. Interview transcripts were analyzed qualitatively to identify recurring themes.

Students often held both cultural and biological understandings of race simultaneously. Participants described race as culturally experienced while also associating it with physical traits and health differences. Students reported encountering misconceptions about race and evolution through social media, including racialized evolutionary hierarchies. Within biology classrooms, discussions about race were largely absent; when related topics were discussed, they were typically framed through genetics alone, which may reinforce biological interpretations. Outside the classroom, students primarily discussed race in cultural or experiential terms and expressed uncertainty about how to address biological misconceptions.

These findings suggest that more explicit integration of instruction at the intersections of race, evolution, and genetics in biology education may help address misconceptions while strengthening culturally competent science communication. This work highlights the importance of incorporating culturally informed discussions of race into undergraduate biology instruction and provides insight to guide future curriculum development and science communication training.

Poster 9: Curriculum Learning for Object Detection under Adverse Weather Conditions via Physics-Based Difficulty Estimation

Presenter: Saroj Baral
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Jorge Vargas

Abstract:

Adverse weather conditions are one of the major hurdles in achieving fully autonomous vehicles. Existing deep learning-based methods for perception under adverse weather include multi-sensor fusion to complement the strengths of one sensor with the weaknesses of another, generative modeling to remove occlusion caused by bad weather, enforcing temporal consistency, and data augmentation with random batch sampling — the latter being a strong and widely adopted baseline. However, training strategy plays an important role in robust perception, and curriculum learning, where the model is exposed to training samples in a meaningful order from easy to hard, has shown improvements over random sampling in several learning tasks. Motivated by this, we explore whether curriculum learning can bring similar benefits to object detection under adverse weather conditions, where the curricular difficulty levels are derived from physics-based modeling of adverse weather phenomena.

Poster 10: Experiences of Mathematics Anxious STEM Students

Presenter: Margarette Grace Bajar
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Dr. Alyson Lischka

Abstract:

Mathematics Anxiety (MA) continues to influence students' engagement and persistence in STEM career pathways. Despite increased attention to affect in mathematics classrooms and extensive research in MA, less in known about the experiences of undergraduate STEM students with MA. This qualitative study investigates the experiences of 10 undergraduate STEM students who self-identified having experienced average to high MA, and their own coping strategies in mitigating their MA. Drawing on semi-structured interviews, data was analyzed using thematic coding to identify patterns related to their experiences and suggestions. Findings suggest that students' MA levels was influenced not only by prior negative experiences but also by perceived instructor support, class environment and structure, and own identity. Participants described shifts in confidence and lowered MA levels when the class structure emphasized growth mindset and active learning, open and welcoming communication, and access to relevant resources for success. These findings can give us insight into how mathematics instructors can support student success not only for mathematics anxious students, but also for any student. Findings can also be beneficial for students who are experiencing MA and develop an action plan in mitigating their MA.

Poster 11: Assessment of Photogrammetric Methods for Saw Mark Analysis

Presenter: Dylan Beerman
Major: Forensic Science
Department: Anthropology
Faculty Mentor: Paul Emanovsky

Abstract:

This research project has not been underway long enough to provide a put together abstract; however, it should be completed come time to present.

Poster 12: Solar Intensity Compared to Solar Activity

Presenter: Gretchen Boeglin
Major: Physics
Department: Physics and Astronomy
Faculty Mentor: Charles Higgins

Abstract:

The purpose of our work is to investigate whether solar burst intensity varies during the solar cycle. We hypothesize that during solar maximum, the intensity of solar bursts is significantly greater than those observed at solar minimum. To test this, we are measuring both the number of solar bursts and their intensities to see if a pattern emerges.

Poster 13: Development of an LCD Spatial Light Modulator and Exploration of Transport of Intensity Imaging

Presenter: Nyah Bentley
Major: Physics
Department: Engineering Technology
Faculty Mentor: Dr. Hongbo Zhang

Abstract:

This project investigates the use of a microcontroller-driven LCD screen as a low-cost Spatial Light Modulator (SLM) for optical experiments. After demonstrating that an ESP32 microcontroller and a 240×240 ST7789 LCD can generate geometric patterns to modulate laser light, the next stage of this research focuses on improving image resolution, developing safer and more reliable ways to display custom graphics, and understanding the limits of the LCD as an SLM. Current work includes creating a new coding method that converts images—such as the MTSU logo—into pixel-based patterns without risking damage to the hardware. In collaboration with another researcher, the project will also use the Transport-of-Intensity Equation (TIE) method to reconstruct a 3D profile of the SLM surface from multiple captured images. These continuing efforts aim to enhance the optical performance of the LCD-based SLM system and build a stronger foundation for future studies in beam shaping and Fourier optics.

Poster 14: Effects of pH on the Biophysical Characteristics of Polymer Hydrolase PahZ1

Presenter: Amy Brown
Major: Chemistry
Department: Chemistry
Faculty Mentor: Justin Miller

Abstract:

Thermally synthesized polyaspartic acid (tPAA) belongs to a class of water-soluble polymers called polycarboxylates, which are used in industries like wastewater treatment and agriculture for their water-absorbent properties and ability to chelate with metals. Polycarboxylates are generally not biodegradable, raising concerns for metal contamination in municipal and drinking water, or soil chemistry disruption in the event of environmental accumulation. tPAA, unlike other polycarboxylates, is fully biodegradable, accredited to a pair of bacterial enzymes: Polyaspartic Acid Hydrolase 1 and Polyaspartic Acid Hydrolase 2 (PahZ1 and PahZ2). PahZ1 cleaves long tPAA chains into smaller oligomers, which may be fully processed into monomers by PahZ2. Since its first isolation from bacterium Sphingomonas sp. KT-1, several homologs of PahZ1 have been discovered in other species, presenting the need for characterization. Leveraging an understanding of the condition-dependent characteristics of PahZ1 and its homologous enzymes will aid in industry implementation and reduce the levels of polycarboxylate accumulation in the environment. This project investigates the effects of pH upon the stability, thermal tolerance, and chemical unfolding of PahZ1.

Poster 15: Valorization of Food and Beverage Waste for Production of Bacterial Cellulose from Kombucha SCOBY

Presenter: Marissa Blair
Major: Fermentation Science
Department: Agriculture
Faculty Mentor: Dr. Keely O'Brien

Abstract:

Kombucha-derived bacterial cellulose demonstrates significant potential for applications in the development of alternative food packaging materials. The valorization of food and beverage waste further enhances the sustainability of this approach by reducing environmental impact and supporting circular production methods. In this pilot study, we evaluated the feasibility of cultivating SCOBYs on alternative fermentation substrates including spent coffee grounds, banana peel waste, and whole banana waste. Successful fermentation and SCOBY growth were observed across all substrates tested. These findings suggest that low-cost, widely available food and beverage waste streams can serve as viable feedstock for bacterial cellulose production. Current research is expanding this work by investigating additional waste-derived substrates, such as dairy whey and fruit waste, to further optimize yield and assess scalability of waste-based SCOBY cultivation for sustainable biomaterial production.

Poster 16: The fidelity of quantum teleportation under a relativistic effect

Presenter: Joey Buckingham
Major: Physics
Department: Physics and Astronomy
Faculty Mentor: Daniel Erenso

Abstract:

The project is a theoretical project on how the fidelity of two photons, of which have some degree of entanglement, is affected by one of the observers moving close to the speed of light. This will induce a Doppler shift onto the photon which will affect the frequency which may affect the fidelity of the photon pairs.

Poster 17: Exploring Science Identity in Biology Education: A Systematic Literature Review

Presenter: Comfort Sarpong Boadu
Major: Mathematics and Science Education
Department: Biology
Faculty Mentor: Dr. Angela Google

Abstract:

Exploring Science Identity in Biology Education: A Systematic Literature Review
Science identity is a central construct for explaining student persistence, belonging, and achievement in STEM education. Biology offers a unique disciplinary context for identity development. Biology identities frequently emerge through authentic research experiences, field courses, and laboratory practices. This systematic literature review examined: 1) How authentic research experiences have been conceptualized and evaluated as mechanisms for science identity development in biology education? 2) How do this authentic research experiences produce sustained identity change among students?
Following PRISMA guidelines for systematic reviews, we conducted comprehensive searches across major education and STEM databases for peer-reviewed studies published between 2007 and 2025. Inclusion criteria required studies to (a) focus on postsecondary STEM contexts, (b) explicitly study science identity, and (c) within biology or life sciences disciplines. After screening 508 articles, 30 studies met inclusion criteria. We adopted the processes developed by Potvin and Hasni (2014) to analyze the 30 studies.
Analysis of the rationale of the studies revealed: Access to authentic research practice is necessary but not sufficient for science identity development, Recognition, belonging, and social validation mediate identity development, Identity development is contextual, timed, and trajectory-dependent, and Science identity is produced within systems of power, culture and meaning. This review identifies the need for: 1) authentic research to be designed beyond participation where they are structured to support reflection, autonomy, and recognition. 2) Instructors and mentors must make recognition explicit; actively name students as legitimate contributors to biology. 3) Classroom practices function as identity-shaping mechanisms and should be intentionally inclusive. 4) Biology identity is shaped by institutional, geographic, and cultural contexts. 5) Science identity is produced within racialized and cultural systems. Asset-based and culturally sustaining pedagogies must be embedded in core biology curricula not isolated programs

Poster 18: Statistics of Radio Jove Solar Observations

Presenter: selah burton
Major: Physics
Department: Physics and Astronomy
Faculty Mentor: Dr. chuck higgins

Abstract:

The objective of this research is to determine statistics of solar radio bursts, when the sun is most active, and how they correlate with the 11-year solar cycle and number of sunspots. Solar radio bursts, produced during flares and coronal mass ejections (CMEs), provide current diagnostics of energetic processes in the corona of our sun and are widely used to indicate conditions in the ionosphere.
Solar radio spectrographs were analyzed to identify and classify solar burst amounts and types. Bursts were categorized as primarily Type II or Type III based on drift rate and shape. Results show burst counts increasing from 2022 to 2024, consistent with the solar cycle, with a majority being Type III bursts. We also see that the sun is inactive for the majority of the year.
The results show a strong relationship between solar radio burst occurrence and the solar cycle and change in sunspots. The study also demonstrates the value of the Radio Jove program in allowing smaller research groups or singular researchers to participate in monitoring and tracking activity in the ionosphere.

Poster 19: Development and Evaluation of Cellulose Kefiran Composite Films for Sustainable Dairy Food Packaging

Presenter: Yashoda Bogati
Major: Fermentation Science
Department: Agriculture
Faculty Mentor: Dr.Keely OBrien
Co-Presenters: Marissa Blair

Abstract:

The main objective of this study is to evaluate a biodegradable cellulose kefiran composite film as a viable alternative for dairy product packaging. Kefiran extracted from wet kefir grain was incorporated with bacterial cellulose, chitosan, beeswax, and lecithin to produce flexible composite films. Film structure stability, dispersion, and interactions were analyzed using confocal Raman microscopy and Fourier transform infrared spectroscopy. Barrier performance was evaluated using ASTM E2945-14 static permeability, and packaging efficacy was assessed by measuring percent weight loss during refrigeration at 7°C and frozen storage.

Preliminary testing found that blueberries covered with composite films lost less weight during refrigerated storage than uncoated fruit, suggesting potential for longer shelf life. Additional methods are necessary to completely evaluate the coating's effectiveness. Cubed cheddar cheese wrapped in composite films showed greater physical stability and lower moisture loss than unwrapped controls in preliminary storage tests. Frozen ground turkey wrapped in composite film-coated paper lost less weight than butcher paper and performed similarly to commercial freezer paper, whereas sealed plastic packaging caused no detectable weight change. Tilapia fillets wrapped in composite-coated paper lost 8.87-10.86% of their weight, compared to 9.74% for butcher paper; freezer paper and plastic packaging showed little to no weight loss. The studies to assess shelf-life extension, texture, moisture retention, and microbiological stability are still in progress.

These findings from the preliminary study support the use of cellulose kefiran composite films and coated paper as sustainable substitutes for petroleum-based packaging in dairy systems, demonstrating that they are efficient moisture-barrier packaging materials in frozen and refrigerated environments without the need for glycerol plasticizers.

Poster 20: Investigating the Role of HIF-1 Induced Glycolytic Shift in Modulating Macrophage Anticryptococcal Activity

Presenter: Emily Callison
Major: Biology
Department: Biology
Faculty Mentor: Dr. David Nelson

Abstract:

Cryptococcosis is a life-threatening systemic fungal infection caused by Cryptococcus neoformans (Cn), a facultative intracellular pathogen that disproportionately impacts immunocompromised individuals. Alveolar macrophages (AMs) serve as the lung's first line of defense against Cn, internalizing the pathogen by phagocytosis, and containing the fungal threat. However, Cn may survive ingestion by these phagocytes and replicate within them before escaping via non-lytic exocytosis (vomocytosis) or transferring between macrophages through dragotcytosis, exploiting AMs as vehicles for dissemination to extrapulmonary sites, including the central nervous system. To better understand this process, this study addresses two aims. First, we investigated whether fetal liver-derived alveolar-like macrophages (FLAMs) could be utilized as an in vitro model to study AM–Cn interactions and compared the behavior of these cells to the macrophage-like cell line, J774, which is frequently used by the field. Using live-cell confocal microscopy, intracellular Cn replication and vomocytosis rates across both macrophage types was imaged and quantified. While replication rates were comparable, FLAMs exhibited a 4.5-fold higher vomocytosis rate. This was accompanied by a distinct HIF-1–dependent glycolytic response in FLAMs which was absent in J774 cells. Second, we examined whether this HIF-1–driven metabolic shift from mitochondrial respiration to glycolysis contributes to intracellular Cn persistence. As a step towards this, we artificially induced HIF-1 activity in J774 cells through treatment with dimethyloxalylglycine (DMOG), a small molecule inhibitor of the prolyl hydroxylase domain enzymes that target HIF-1 proteins for degradation. We then titrated the HIF-1 inhibitor, echinomycin, into these cultures to determine the minimal echinomycin dose necessary to block HIF-1 activity in macrophages. These optimized conditions will then be applied to FLAMs to assess the impact of HIF-1 inhibition on antifungal defense during Cn infection. Together, this work seeks to advance our understanding of pathogen-driven metabolic remodeling and potential therapeutic targets for combating cryptococcosis.

Poster 21: Testing a Six-Dimensional Framework for How University Teachers and Students View the Nature of Mathematics

Presenter: Christopher Bonnesen
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Dr. Jeremy Strayer

Abstract:

This poster showcases the preliminary results from implementing a survey measuring views of the nature of mathematics (NOM) to approximately 300 university mathematics instructors and students. The survey seeks to measure participants' views regarding six distinct scales/dimensions of NOM, defined as Certainty, Proceduralism, Connectedness, Externalism, Process-View, and Culture-Dependence. This six-dimensional framework was developed by the author via a literature review. After cognitive interviews were conducted to establish evidence of survey validity, the revised 44-item Likert-scale survey was administered to approximately 300 university-level mathematics students and instructors. The goal of this implementation is to establish evidence of survey reliability and to further refine both the survey and the underlying framework. Initial findings include good values of Cronbach's alpha for Proceduralism and Externalism, acceptable values for Connectedness and Culture-Dependence, and poor values for Certainty and the Process-View. Other findings include specific wording or reverse-coding that skewed the mean response for items within a specific dimension. These findings will influence how both the framework and survey items will be revised for future implementations.

Poster 22: Toward Autonomous Laboratories: Vision-Driven Robotic Decision-Making via Imitation Learning

Presenter: Alysa Chanthayom
Major: Data Science
Department: Computer Science
Faculty Mentor: Dr. Arthur Williams

Abstract:

Automating the physical experimentation process transforms the scientist's role from manual operator to strategic decision-maker, enabling human expertise to focus on hypothesis generation and interpretation while intelligent systems manage execution. Conventional robotic systems rely on fixed control policies and scripted motion plans, limiting adaptability and necessitating reprogramming when environmental conditions or task requirements change. To address this limitation, we trained a robot to plan its actions using visual input from multiple camera perspectives. Using an artificial intelligence (AI) technique known as imitation learning, we trained the robot on two manipulation tasks of increasing complexity. The first task involved grasping an object and placing it within a predefined target region. The second task required the robot to visually localize and grasp a test tube, then execute a learned, orientation-sensitive pouring motion into a beaker, modeling a foundational step in chemical laboratory workflows. Collectively, these results demonstrate that AI-enabled robotic systems can achieve robust, adaptive decision-making, providing a scalable foundation for next-generation autonomous laboratory infrastructure.

Poster 23: Aggregate versus Individual Loss Reserving: A Longitudinal Comparison for Growing Insurers

Presenter: Wendi Chen
Major: Actuarial Science
Department: Mathematics
Faculty Mentor: Vijiara Manathunga

Abstract:

Should actuaries at newly established insurers predict aggregate loss reserves using traditional aggregate methods or by aggregating individual claim-level model predictions? Unlike prior research comparing these approaches at single evaluation points, we examine performance evolution over a 20-year horizon as claims experience accumulates. We impose early-stage constraints: no external data supplementation and no professional judgment overrides. Within this framework, we compare the chain-ladder method against modern individual-level models including Bayesian mixture density networks with LSTM architectures, transformer-based mixture density networks, and hybrid LSTM-transformer models. Despite the analytical appeal of granular modeling and its compatibility with machine learning techniques, prior research suggests individual-level models often fail to outperform traditional aggregate methods. Our longitudinal design tests whether this finding holds consistently or varies with data maturity, providing practical guidance for actuaries navigating the trade-off between methodological sophistication and predictive accuracy.

Poster 24: Defining Undergraduate Science Communication Education: Emphasis, Evaluation, and Collaboration

Presenter: Kate Coscia
Major: Mathematics and Science Education
Department: Biology
Faculty Mentor: Dr. M. Elizabeth Barnes

Abstract:

Effective science communication has been identified as an essential skill not only for professional scientists but also for undergraduate students who are already engaging in conversations about science in classrooms and their communities. Although research on undergraduate science communication education has been expanding, we still do not have a comprehensive overview of what undergraduate science communication education looks like, how success is measured, and who is shaping the field.

We conducted a systematic review of the science communication education research literature, focusing specifically on undergraduate contexts. As part of this review, we explored patterns in the literature, including which forms of communication are emphasized, how effectiveness is evaluated, and how researchers collaborate across disciplines.

Most undergraduate science communication education focuses on audience communication or scientist-to-scientist communication. Interpersonal communication instruction is rare, even though undergraduate students are already actively having these conversations about science with friends, family members, and others in their communities.

Although many studies report positive outcomes from science communication instruction, they do not always provide strong support for the measures used to assess those outcomes, and the research itself is largely conducted by science education scholars with little sustained collaboration from communication researchers. This lack of robust evaluation and interdisciplinary collaboration makes it hard to develop evidence-based instruction that can prepare students for the one-on-one scientific conversations they are having in their everyday lives.

Poster 25: A New Root Rot Threat to American Ginseng: Identification and Biocontrol of Ilyonectria pseudodestructans

Presenter: Senthilraja Chinnaiah
Major: Agriculture
Department: Agriculture
Faculty Mentor: Dr. Ying Gao
Co-Presenters: Ying Gao

Abstract:

American ginseng (Panax quinquefolius) is an economically important medicinal crop affected by root rot diseases caused by species within the Ilyonectria and Cylindrocarpon complexes. In this study, Ilyonectria pseudodestructans was isolated and identified as the causal agent of root rot in American ginseng using morphological characteristics and multilocus molecular analyses (rDNA-ITS, TUB, and H3). Approximately 20% of stored roots developed rot symptoms, and planted roots exhibited wilting and severe root decay. Phylogenetic analysis confirmed the pathogen identity. Biocontrol screening showed that Trichoderma harzianum and Bacillus velezensis strain N1 inhibited mycelial growth by up to 98% and 86%, respectively. Microscopic observations of N1-treated samples showed damaged fungal hyphae and suppressed conidial production. This study represents the first report of I. pseudodestructans causing root rot of American ginseng in Tennessee and the United States and identifies potential biocontrol agents for disease management.

Poster 26: Chryseobacterium and Stenotrophomonas as models to understand pathogen induced dysbiosis of the microbiome.

Presenter: Johanna Crick
Major: Biology
Department: Biology
Faculty Mentor: Dr. Donald Walker

Abstract:

Snake fungal disease (SFD) is an emerging infectious disease caused by the fungal pathogen Ophidiomyces ophidiicola that affects snake species and causes dysbiosis (disruption) of the skin microbiome. Previous studies have identified certain bacterial genera, including Chryseobacterium and Stenotrophomonas, as important members of the skin microbiome and predictors of disease state. By exploring model taxa in the skin microbiome, this study advances fundamental knowledge of the ecology and evolution of the skin microbiome in response to fungal pathogen induced dysbiosis. I isolated Chryseobacterium, Stenotrophomonas, and other bacterial genera from samples taken from disease positive and negative wild Crotalus horridus (Timber Rattlesnakes), and enriched communities from disease negative Nerodia erythrogaster (Plain-bellied Watersnakes). Samples were grown on and isolated from 1% keratin or R2A plates before performing DNA extraction and Sanger sequencing to determine identity. Chryseobacterium and Stenotrophomonas were present across disease states, and diversity differed among samples, indicating a potential change in culturable microbes in response to O. ophidiicola and helping inform which bacterial genera may be important in resisting SFD.

Poster 27: Methods of Adhesion for Growing Eunapius Fragilis

Presenter: Gracie Choate
Major: Biology
Department: Biology
Faculty Mentor: Cole G. Easson

Abstract:

Title: Methods of Adhesion for Growing Eunapius fragilis

Word Count: 200

Most freshwater sponge specimens are collected in the field. Growing them in the lab for study can be done but growing them in the field proves largely difficult. The purpose of this project is to find efficient methods of manually adhering sponge gemmules to be grown in the field for further study. To adhere the gemmules manually, a couple of methods were tested. Two glues, Duro Superglue and bsi IC-Gel, were used to glue down gemmules, and for a third method, a mesh net was glued in place over the gemmules to keep them in place. Some of the information we hope to gather is which method holds the gemmules in place the best, whether the methods hinder sponge growth at all, and which method is the easiest to use.

These methods will be tested over several weeks and multiple runs. The first run has been set up and is being monitored, while the second will commence the week of March 16th, and a third will commence the week of April 6th. Although the data is preliminary, the mesh method appears to hinder natural adhesion and growth the most, while the two glues are about the same in allowing growth.

Poster 28: Palmar digital perineural analgesia, as an experimental model for nerving in navicular disease, anticipated effects on forelimb loading in sound horses.

Presenter: Morgan Delaney
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

Navicular disease is characterized by degeneration of the navicular bone and surrounding soft tissues. It is a common cause of forelimb lameness and often presented as heel pain. Palmar digital neurectomy (nerving) is used as a surgical treatment to remove the sensation in the heel. Palmar digital perineural analgesia (blocking) is a local anesthetic that temporarily removes the sensation within the heel and is frequently used as a diagnostic tool. A recently-published pilot study found temporarily removing the heel sensation in the forelimbs of sound horses results in horses loading the heel region more heavily. The objective of this study is to examine the effects palmar digital perineural analgesia on forelimb loading in the sound horse on hard and soft ground at the walk and trot gaits. Ten horses scoring a 1 or less on the AAEP Lameness Scale will be fitted to Tekscan hoof sensors and set via EasyShoe glue-on shoes on the front hooves. Each horse will complete a set of exercises, including walking and trotting a straight line in-hand on both hard and soft ground. This will be performed in a random order, once as a control prior to nerve blocking. Then horses will be nerve-blocked and a second set of randomized tests will be performed.[GU1.1][GU1.2] Sensors connect to a computer and provide normal force, loaded area, and calulated pressure. The results from this study will [GU2.1]contribute insight into how nerving a horse's forelimbs may affect hoof loading. Further research is needed to determine the long-lasting effects of a change in forelimb hoof loading and meaning for the welfare of performance horses.

Poster 29: NOVEL COLCHICINE BINDING SITE INHIBITOR OVERCOMES TAXOL RESISTANCE IN METASTATIC MELANOMA IN VIVO VIA DUAL APOPTOSIS AND NECROPTOSIS PATHWAYS

Presenter: Christopher Clark
Major: Molecular Bioscience
Department: Chemistry
Faculty Mentor: Dr. Souvik Banerjee

Abstract:

Metastatic melanoma is one of the deadliest forms of skin cancer and is responsible for 80% of total deaths from skin cancer. According to the American Cancer Society, the 5-year survival rate for patients with distant metastasized melanoma is only 31%. Targeted therapy and paclitaxel treatment are well documented to develop resistance upon prolonged treatment. Previous literature has indicated that colchicine binding site inhibitors (CBSIs) are promising candidates for the treatment of resistant variants of difficult-to-treat cancers, including melanoma. In this study, we designed a new series of CBSIs based on a novel scaffold and evaluated their biological activity. Out of the synthesized 35 compounds, we identified our lead compound 9d, which was confirmed as a CBSI and demonstrated potent antiproliferative activity in the 15-20 nM range against a panel of melanoma cell lines. In vitro, compound 9d arrested the cell cycle in the G2/M phase of treated cancer cells and inhibited behaviors such as migration, invasion, and colony-forming ability. In vivo, compound 9d significantly inhibited tumor growth in a syngeneic B16-F10 mouse model. IHC and H&E staining of tumor slides revealed that 9d treatment inhibited tumor cell proliferation, induced both apoptosis and necroptosis, and caused immune cell recruitment into treated tumors. This unique effect was further characterized in vitro, where the induction of necroptosis could be prevented by co-treatment with the necroptosis inhibitor Necrostatin-1. Overall, 9d demonstrated strong antitumor activity in vivo while maintaining a comparable safety profile to the standard-of-care drug paclitaxel and did not demonstrate any systemic toxicity. Future studies are planned for more potent 9d analogs, such as the recently synthesized compound M21, demonstrating single-digit nM efficacy across diverse cancer cells.

Poster 30: Design, synthesis, and biological evaluation of novel phenyl(quinoline) methanone-based colchicine-binding site inhibitors

Presenter: Lydia Folorunsho
Major: Biomedical Sciences
Department: Chemistry
Faculty Mentor: Dr. Souvik Banerjee

Abstract:

Cancer remains a major health problem worldwide, driven by genetic changes that disrupt normal cell growth and spread. Advanced cancers are often treated with drugs like paclitaxel and docetaxel, which target microtubules. Microtubules are components of the cytoskeleton that are required for maintaining cell shape, intracellular transport, and, most significantly, chromosomal segregation during mitosis. Their ability to switch between polymerization and depolymerization, known as dynamic instability, is closely regulated in healthy cells. Cancer disrupts this regulatory balance, causing malignant cells to divide uncontrollably. Because microtubules are essential for mitotic spindle formation, compounds that disrupt their function have emerged as an effective treatment for cancer. However, many existing microtubule-targeting drugs, like paclitaxel, have major drawbacks, such as off-target toxicity, low solubility, metabolic instability, and multidrug resistance. These shortcomings highlight the need for novel scaffolds that can bind tubulin more selectively, overcome resistance, and sustain potent antiproliferative activity. We report that the initiative attempts to overcome some of these challenges by developing a new class of phenyl(quinoline)methanone analogs designed to bind to the colchicine-binding site (CBS) at the interface of αβ-tubulin, a well-established groove that inhibits tubulin polymerization when occupied. The quinoline core provides a versatile foundation for synthetic modification, allowing for comprehensive adjustment of electronic, steric, and hydrogen-bonding properties to increase tubulin binding and improve the potency of the molecules. Using structure-based molecular modeling, ten compounds were synthesized that could potentially optimize interactions with CBS and ensure drug-like properties. These compounds were then tested on cancer cells to determine their potency. A few of these compounds proved to have IC50 values below 1 μM, indicating that further modifications can lead to more potent and selective compounds. These molecules would be further evaluated for their mechanism of action studies and their ability to induce apoptosis (programmed cell death) in cancer cells.

Poster 31: Relativistic Dirac–Hartree–Fock X-ray scattering factors. III. Chemically relevant atomic anions

Presenter: Hampton Copeland
Major: Chemistry
Department: Chemistry
Faculty Mentor: Anatoliy Volkov

Abstract:

Relativistic X-Ray Scattering Factors (XRSFs) are reported for all chemically relevant anions for atoms with Z=1-85. The Four-component Dirac-Hartree-Fock (DHF) wavefunctions were calculated for each species with a modified DFRATOM package [Matsuoka & Watanabe, 2001].
The procedure was validated by comparing energies of neutral atoms to high-quality reference data from [Visscher & Dyall, 1997], and the most recent electron affinities reported in the CRC Handbook of chemistry. Unlike previous studies that utilized hard potentials (e.g., Watson sphere approximation), a new, soft-confinement potential was introduced to prevent valence electrons of multivalent atoms from expanding to unbound states.The resultings XRSFs are especially relevant to heavy P-block anions which experience significant relativistic effects and have multiple anionic states.

Poster 32: Structure- Activity Relationship of MTL1-44 Peptoid Derivatives Against Staphylococcus aureus

Presenter: Mary Gendy
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Dr. Kevin Bicker

Abstract:

Antibiotic-resistant bacterial infections continue to pose a major challenge to public health and emphasize the need for new antimicrobial agents. Staphylococcus aureus, including methicillin-resistant S. aureus (MRSA), is especially concerning because of its virulence, resistance to commonly used antibiotics, and role in serious skin, soft tissue, and bloodstream infections. As resistance to current treatments increases, alternative therapeutic strategies are needed. Antimicrobial peptoids are promising candidates because they can mimic the activity of antimicrobial peptides while offering improved resistance to proteolytic degradation.

This project investigated the antibacterial potential of the peptoid MTL1-44 and related derivatives against S. aureus. Antibacterial activity was evaluated using broth microdilution minimum inhibitory concentration (MIC) assays, which measure the lowest concentration of compound required to inhibit bacterial growth. Initial studies compared the parent compound, MTL1-44, with a modified derivative, MTL1-44-1, to determine whether chemical modification affected antibacterial activity. In addition, mammalian cytotoxicity of previously synthesized sarcosine derivatives was assessed in HepG2 cells using an MTT assay to determine toxic dose 50% (TD_{50}) values. These studies provided important information about compound activity and cell compatibility. Building on these results, additional derivatives of MTL1-44 were synthesized and tested against S. aureus to continue evaluating their antibacterial effects.

Overall, MTL1-44 demonstrated promising antibacterial activity, and cytotoxicity testing helped identify compounds with more favorable biological profiles. These findings contribute to the broader evaluation of peptoids as potential antimicrobial agents and support continued investigation of MTL1-44 and related derivatives. This work highlights the potential of peptoid-based compounds as candidates for the future development of treatments targeting drug-resistant bacterial infections.

Poster 33: Bridging the Gap Between STEM Teaching and Student Perspectives

Presenter: Lucas Davis
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Dr. Sarah Bleiler-Baxter

Abstract:

Despite reform STEM higher education being focused on student-centered teaching, the voices of students impacted by these reforms are often ignored or underrepresented. Even as instructors shift towards evidence-based learning practices, students may still feel unsupported by instructors, overwhelmed, disconnected, or unheard. These patterns are not unique to higher education; where employees may have unspoken needs or concerns that never surface. Using Self-Determination Theory (SDT) as a guiding framework, this project examines these gaps by focusing directly on student perspectives of competence, autonomy, and relatedness, giving voice to the students who are benefactors of STEM education reform yet are often the least consulted.

To explore these questions, we administered a modified version of the Basic Psychological Needs Satisfaction and Frustration Scale (BPNSFS) to approximately 285 students across seven STEM-affiliated departments at a large public university. Our survey captures how students perceive instructors' support for competence, autonomy, and relatedness. Because students represent a wide range of the dataset provides a diverse view of how STEM courses are experienced across the college.

Descriptive statistics identified trends in need satisfaction and frustration. This study reveals the effectiveness of instructional supports for psychological needs and identifies areas where additional support could enhance students' motivation and sense of belonging. The study provides a framework for understanding how perception of psychological needs can shape motivation and well-being across contexts. This study is part of a broader project attempting to advance teaching culture in STEM departments. In presenting these findings to the college community, we aim to facilitate a dialogue regarding the critical role of student voice in educational reform. By highlighting these department-specific trends, this work contributes to our broader initiative to advance teaching culture and improve student outcomes within the university's STEM programs.

Poster 34: Design, synthesis, and biological evaluation of novel imidazoquinoline-based colchicine-binding site inhibitors

Presenter: Naime Beyza Gokce
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Souvik Banerjee

Abstract:

Cancer is one of the leading causes of death worldwide, and many current treatments work by targeting microtubules, which are essential for cell division. Drugs such as paclitaxel disrupt microtubule function and prevent cancer cells from dividing. However, over time, many cancers develop resistance to these treatments, making them less effective. Therefore, there is a need to develop alternative microtubule inhibitors that can overcome these limitations. This project focuses on designing and synthesizing new imidazoquinoline-based compounds that target the colchicine binding site on tubulin. Inhibitors that bind to this site may avoid some common resistance mechanisms and could provide an alternative strategy for treating advanced and metastatic cancers. First, molecular docking studies will be used to predict how well the designed compounds interact with tubulin. Promising candidates will then be synthesized and characterized using standard organic chemistry techniques. The biological activity of the synthesized compounds will be evaluated using MTT cell viability assays in cancer cell lines such as melanoma and metastatic breast cancer cells. Compounds that show strong activity will also be tested in paclitaxel-resistant cell lines to determine whether they can overcome drug resistance. Overall, this research aims to identify potential lead compounds that could contribute to the development of more effective cancer therapies.

Poster 35: Evaluation and Optimization of the Antibacterial and Cytotoxic Effects of Anti-Staphylococcus Peptoids

Presenter: Robert Davis
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Dr. Kevin Bicker

Abstract:

Bacterial antibiotic resistance is a growing global health concern. Staphylococcus aureus is one of the six ESKAPE pathogens, a group of multidrug-resistant bacteria for which new antibiotics are urgently needed. Antimicrobial peptides (AMPs) have shown promise as antibacterial agents because bacteria are less likely to develop resistance against them. However, AMPs are highly susceptible to proteolytic degradation, resulting in poor biostability. Peptoids, a class of peptidomimetics, represent a promising alternative due to their structural similarity to peptides combined with improved stability and bioavailability.The goal of this study is to evaluate the antibacterial activity and cytotoxicity of twelve MTL1-series peptoids and to identify a lead compound for further optimization through a structure–activity relationship (SAR) study. Minimum inhibitory concentration (MIC) values were determined against multiple Staphylococcus strains. Based on low MIC values and cytotoxicity (TD50) data obtained from HepG2 cells, HaCaT keratinocytes, and human red blood cells (RBCs), a lead compound will be selected for subsequent SAR optimization.

Poster 36: Identifying Novel Phages in Local Environmental Sources for Potential Phage

Presenter: Ellaleigh Hall
Major: Biochemistry
Department: Biology
Faculty Mentor: Rebecca Seipalt-Theimann

Abstract:

There is a rising death rate caused by antimicrobial resistance (AMR) around the world. This is due in part to the mis-use and overuse of antibiotics. Bacteria that cause otherwise curable illnesses evolve in opposition to antibiotics, when exposed to these medicines. One promising alternative to antibiotics is bacteriophage therapy. The purpose of this research is to find and characterize phages that exist in environmental sources such as raw water and test them against common bacteria. The current collection of clinically-available phages is limited but growing, and our aim is to add new specific phages to the pool that can be used in clinical therapeutic treatment. First, we collected water from local raw water sources around Murfreesboro and ran an initial phage isolation test with three hosts. Once phages appeared on plate, they were isolated using phage buffer and isolated again to confirm single phage. The five phages were tittered, used to make high titer stocks from which DNA will be isolated and characterized. DNA characterization will include restriction enzyme analysis and DNA sequencing. Additionally, we will characterize genome features of these new phages and compare them to existing phages. The phages will be deposited with the Van Tyne group at the University of Pittsburgh for clinical use.

Poster 37: Development of Field-Deployable Diagnostics for Biomedical, Forensic, and Security Applications

Presenter: Chloe Earls
Major: Chemistry
Department: Chemistry
Faculty Mentor: Jan Halamek

Abstract:

The increasing prevalence of highly toxic substances, including illicit drugs and organophosphorus compounds, has created an urgent need for rapid and reliable detection methods to protect personnel operating in the field. Current methods for toxicology testing rely on invasive collection of blood or urine samples, followed by time-consuming, centralized laboratory analysis that is highly susceptible to false negatives due to sample degradation. These current approaches limit the effectiveness of law enforcement, first responders, and military personnel who are operating in such dynamic environments.

The Halámek Research Group is focused on developing advanced biosensing technologies designed to provide portable, rapid, and user-friendly detection of toxic compounds directly at the point of need. By eliminating the reliance on complex laboratory analysis, these systems can enhance response times and improve safety in high-risk environments.

This research is centrally focused on the use of nonconventional sampling strategies that incorporate the combination of alternative biological matrices and novel biochemical assays. These assays involve the integration of optical detection platforms that produce clear colorimetric outputs, enabling straightforward visual interpretation without any specialized equipment. This innovative approach improves both the accessibility and practicality of toxic substance screening in field conditions. Collectively, these advances seek to improve speed, accuracy, and reliability of toxic compound detection while broadening the contexts in which effective screening can be performed.

Poster 38: A Framework for Exploring Adaptive Teaching: The Adaptive Teaching Tetrahedron

Presenter: Sarah Hartman
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Alyson Lischka

Abstract:

The ability to adapt to the unexpected in the classroom is an important skill for all teachers to possess. This skill, adaptive teaching (AT), is under-theorized in mathematics education and suffers from a lack of consistency in definition. This poster proposes a conceptual framework called the Adaptive Teaching Tetrahedron (ATT), built upon themes from existing literature. The framework was developed through an iterative hermeneutic phenomenological process and conjectures a relationship between various literature bases in and around AT. The poster also presents preliminary results from a study with three mathematics teacher educators and their perceived moments of adaptive teaching. Results indicate instructors' perceptions of adaptive teaching as well as their adaptive actions are conducted and interpreted through the lens of participants' beliefs about students, classroom instruction, and reflective capacity. which has implications for the interpretation of the ATT in an instructional setting. Implications for the mathematics education research and teaching community are presented as well.

Poster 39: Growth Performance of Lavender, Rosemary, Sage, and Thyme Cultivars for Beginning Farmers in Middle Tennessee

Presenter: Ally Fowler
Major: Physics
Department: Agriculture
Faculty Mentor: Ying Gao

Abstract:

Lavender, rosemary, sage, and thyme are increasingly popular specialty crops among beginner farmers in the Southeastern United States. However, Tennessee's hot, humid summers and periodic winter cold snaps present challenges for establishing certain cultivars, particularly those adapted to Mediterranean or tropical climates. This study evaluated cultivar performance under Middle Tennessee growing conditions to determine which plants demonstrate the greatest consistency and resilience.

In March 2025, eighteen plants representing lavender, rosemary, sage, and thyme cultivars were established in raised-bed conditions. Monthly measurements of plant height and width were collected through January 2026. Overall plant health, as well as the presence of buds or flowers, was documented throughout the growing period.

After six months of observation, lavender demonstrated the greatest overall hardiness. The eight lavender plants were least affected by extreme summer heat and winter cold compared to the other species; however, only two lavender cultivars produced flowers. Sage and rosemary exhibited greater sensitivity to climatic stressors.

These findings provide practical expectations for beginner growers interested in ornamental, culinary, or small-scale specialty crop production in Middle Tennessee. Future research should incorporate more precise measurement techniques and expanded photographic documentation to strengthen long-term evaluation and cultivar comparison.

Poster 40: Novel Antimitotic Cancer Drug Synthesis: Triazoloquinazolininone-Based Colchicine Binding Site Inhibitors

Presenter: Braedyn Hollingsworth
Major: Chemistry
Department: Chemistry
Faculty Mentor: Souvik Banerjee

Abstract:

Breast cancer is one of the leading cancer diagnoses for women in the United States with one in eight women being diagnosed with an invasive form in their lifetime1,2. Prostate cancer is the most prevalent cancer diagnosis amongst men accounting for 30% of men's cancer diagnoses in 2025 and is the second most likely cancer to end in mortality for men3. Antimitotic drugs are a way to inhibit growth and prevent cancers from spreading at unprecedented rates. Colchicine binding site inhibitors show promise for both potency (lower amount needed to produce a therapeutic dose) and reduction in multidrug resistance. Each of the nine compounds were synthesized using a three to five part synthesis which produced decent yield at around X%. The synthesis of these novel compounds was the next step in potential anticancer treatments for those in late-stage metastasis.

(1) Siegel, R. L.; Giaquinto, A. N.; Jemal, A. Cancer Statistics, 2024. CA Cancer J Clin 2024, 74 (1), 12–49. https://doi.org/https://doi.org/10.3322/caac.21820.
(2) American Cancer Society. Breast Cancer Facts & Figures 2024-2025. American Cancer Society 2024.
(3) Kratzer, T. B.; Mazzitelli, N.; Star, J.; Dahut, W. L.; Jemal, A.; Siegel, R. L. Prostate Cancer Statistics, 2025. CA Cancer J Clin 2025, 75 (6), 485–497. https://doi.org/https://doi.org/10.3322/caac.70028.

Poster 41: Endogenous Salivary Butyrylcholinesterase as a Biorecognition Element for Organophosphate Detection

Presenter: rosalenda gendy
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Jan Halamek
Co-Presenters: Marina Saad

Abstract:

Organophosphates (OPs) have been used as chemical warfare agents because of their strong neurotoxic effects. These compounds cause harm by irreversibly inhibiting cholinesterase enzymes, primarily acetylcholinesterase (AChE) and butyrylcholinesterase (BChE). When these enzymes are blocked, acetylcholine builds synapses, resulting in disrupted nerve signaling and severe physiological effects. Ellman's assay, first described by George L. Ellman, is a well-established spectrophotometric method for measuring cholinesterase activity. The assay detects enzyme activity through the formation of a yellow-colored product generated in a thiol-based reaction, which can be quantified by measuring absorbance. Because organophosphate exposure reduces enzyme activity, this decrease can be translated into a measurable signal for detection. Many previously developed biosensors for OPs rely on externally supplied purified enzymes, which can present challenges related to enzyme stability, storage, and field use. In this proof-of-concept study, we examined whether endogenous butyrylcholinesterase in human saliva could be inhibited by an organophosphate, paraoxon-ethyl. The results confirmed measurable inhibition, demonstrating that naturally occurring cholinesterase can act as the bio recognition element. This approach removes the need for added enzymes and supports the potential development of a minimally invasive platform for rapid organophosphate exposure assessment.

Poster 42: Effect of Metal-Dications on the Rate of the Aqueous Reaction of Benzyl Substituted N-(Hydroxybenzyl)benzamide

Presenter: Lexi Huff
Major: Chemistry
Department: Chemistry
Faculty Mentor: Richard Nagorski

Abstract:

Carbinolamides are intermediates in the formation of C-terminal α-amidated peptide hormones where the α-amide is critical for hormone activity. The carbinolamide functionality has also been shown to be necessary for the bioactivity of the commercially available antibiotic, Bicyclomycin, in addition to carbinolamides having other roles which have both positive and negative impacts on the organism involved. While studies performed in the group have expanded the understanding of the mechanism by which these compounds react under aqueous conditions, many questions remain. One significant puzzle is the mechanism by which peptidylglycine α-amidating monooxygenase (PAM) catalyzes the breakdown of the carbinolamide intermediate generated during the synthesis of the peptide hormones from glycine-extended peptide precursors. The lyase portion of the bifunctional enzyme PAM contains a Zn2+ ion, whose role in catalysis is not well understood. It is known that if the Zn2+ is not present, the enzyme becomes inactive. Proposed roles for the metal-ion include structural, zinc-bound hydroxide and direct interaction of the substrate and metal ion. The study will probe the effect of substituents, on the carbinol portion of N-(hydroxybenzyl)benzamide, on the rate of metal-catalyzed breakdown for both the acid and hydroxide catalyzed reactions. The results of kinetic studies where the [Zn2+] will be varied in the acid-catalyzed and the hydroxide-dependent regions of the pH-rate profile. Based upon the metal-catalysis studies, a role for the metal-ion in the enzyme catalyzed reaction will be proposed.

Poster 43: Quantifying Background Dependence in Static ASL Alphabet Classification

Presenter: Marina Gerges
Major: Computer Science
Department: Computer Science
Faculty Mentor: Dr. Joshua L. Phillips

Abstract:

Automatic recognition of American Sign Language (ASL) alphabet images is commonly treated as a visual classification task in which deep neural networks learn to distinguish hand shapes corresponding to letters. Although state-of-the-art models achieve high accuracy on benchmark datasets, most ASL datasets are collected in controlled environments with consistent lighting and simple backgrounds. Under these conditions, models may unintentionally learn spurious correlations between letter classes and environmental context rather than relying solely on hand shape features, limiting robustness in real-world settings.

This study aims to investigate the extent to which static ASL alphabet classifiers depend on background cues and to evaluate whether systematic background randomization improves generalization. Classifiers trained with conventional augmentations (e.g., rotation and brightness adjustments) will be compared to classifiers trained with mask-based background replacement, where the hand region is preserved and the surrounding background is replaced with diverse scenes. Model performance will be evaluated using accuracy, precision, recall, and F1-score under both standard testing and cross-environment testing conditions. Visualization techniques such as saliency maps and Grad-CAM will be used to assess whether attention shifts from background regions to the hand region when background randomization is applied.

It is hypothesized that models trained with systematic background randomization will demonstrate improved robustness and reduced performance degradation when evaluated on images with novel backgrounds. This work seeks to enhance the reliability and real-world deployment potential of ASL recognition systems.

Poster 44: Glycemic and Insulinemic Responses of Horses to Abrupt Forage Type Switching

Presenter: Nicole Imbeault
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

Forage comprises the majority of the equine diet, yet the metabolic impacts of abrupt hay changes remain underexplored. Sudden hay switching may occur during travel, or forage shortages, and may have important implications for performance horses. Non-structural carbohydrates (NSC), including sugars and starches, vary considerably among hay types and are quickly digested and absorbed, influencing postprandial blood glucose and insulin levels. Although glycemic responses for short-stem forages have been evaluated, limited research has examined these responses in long-stem hay following rapid dietary transition. The objective of this study is to determine how sudden changes among hay types differing in NSC concentration affect postprandial glycemic and insulinemic responses in mature horses. It is hypothesized that hays with greater NSC concentrations, and rapid consumption of chopped, compared to long-stemmed hay, will produce greater blood glucose and insulin area under the curve (AUC) values. Eight mature horses will be utilized in a 4 × 4 Latin square design with four dietary treatments: prairie grass hay (control), orchardgrass hay, chopped orchardgrass hay, and alfalfa hay. Each treatment period will consist of six days of adaptation followed by an abrupt transition on day seven to either a new hay type or continuation of the control. Horses will receive the assigned hay at 0.5% of body weight, and blood samples will be collected via jugular venipuncture prior to and hourly for 5 hours post-feeding. Postprandial glucose and insulin concentrations will be measured, and AUC will be calculated to assess the overall postprandial response. All hays will undergo laboratory analysis for NSC content, and data will be analyzed using mixed models with repeated measures. Findings from this study will contribute to evidence-based forage management recommendations, particularly for performance horses and those at risk for metabolic dysfunction.

Poster 45: Departmental Supports and Barriers to Graduate Student Teaching Professional Development: An Interview Study

Presenter: Heather Green
Major: Mathematics and Science Education
Department: Biology
Faculty Mentor: Grant Gardner

Abstract:

Attrition in STEM majors is an issue of concern in undergraduate institutions (Smith &Willison, 2021). Among the reasons students cite for leaving STEM majors are poor teaching, difficulties with instructors' focus on "right" answers, and lack of belongingness (Gafney, 2005; Smith & Willison, 2021; Stains et al., 2018). Connelly et al. (2016) found 94% of doctoral students taught at some point during their doctoral studies and nearly half of those students were teaching undergraduates within 5 years of receiving their degrees. Thus, graduate students are a significant portion of instructors in higher education institutions. In addition, graduate teaching assistants have positive effects on undergraduate students (Connelly et al, 2016; Gin et al., 2021). Despite this position as developing instructors, GTAs often receive little to no effective teaching professional development (Gardner & Jones, 2011; Stains et al., 2017). Based on data from a Delphi study, this study aimed to compare supports and barriers to the development of effective GTA PD across institutions to determine common themes promoting or detering the implementation of GTA PD. This study is based on the theoretical framework of the four frames model for institutional change (Reinholz & Apkarian, 2018). It utilized semi-structured interviews of experts from 35 institutions regarding supports and barriers at their individual institutions. These interviews were part of a larger NSF grant funded Delphi study. Responses were deductively coded into four frames: symbols, structures, people, and power, and inductively coded within each frame. Our research question was: What supports and barriers do GTA PD providers and researchers identify as crucial factors of departmental culture affecting the presence and quality of GTA PD? Most of the identified supports and barriers were in the structures and symbols frames. These results suggest that changes in these frames could be vital to implementation of GTA PD.

Poster 46: Evaluating and Adapting Transformer-Based ASR Under Singing-Style Mandarin Domain Shift

Presenter: Lingshan Jiang
Major: Computer Science
Department: Computer Science
Faculty Mentor: Joshua L. Phillips

Abstract:

Automatic Speech Recognition (ASR) systems have achieved strong performance on conversational speech using large transformer-based models such as OpenAI's Whisper. However, these systems remain vulnerable to acoustic domain shift, where speech characteristics differ substantially from training data. Singing-style speech, particularly traditional Beijing Opera (Jingju), presents a structured and underexplored domain shift due to elongated vowels, exaggerated pitch contours, stylized pronunciation, and rhythmic variation.

This project systematically evaluates the robustness of transformer-based ASR models under singing-style Mandarin speech conditions. Using publicly available conversational Mandarin datasets (e.g., THCHS-30) and curated Beijing Opera corpora, we measure baseline degradation in Character Error Rate (CER) and analyze error patterns including vowel deletions and tonal substitutions. Statistical significance testing is applied to quantify performance differences across domains.

To mitigate observed degradation, we investigate domain-adaptation strategies including parameter-efficient fine-tuning (LoRA), pitch-shift data augmentation, and acoustic normalization techniques. Finally, we assess downstream translation quality using BLEU and COMET metrics to determine how ASR errors propagate into machine translation outputs.

Beyond technical robustness analysis, this research contributes to digital cultural preservation by improving subtitle generation for traditional performance art. The findings provide insight into ASR behavior under structured acoustic variation and inform broader strategies for improving inclusive speech technologies in underrepresented and stylized speech domains.

Poster 47: Implications of using Plan-Do-Study-Act Cycles to Address Problems of Practice in Secondary Mathematics Teacher Preparation

Presenter: Sarah Hartman
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Alyson Lischka
Co-Presenters: Sarvani Pemmaraju

Abstract:

To address the problems of recruitment, retention, and quality mathematics instruction in secondary mathematics teacher preparation programs, a national partnership of these programs (MTEP) was formed. The partnership leverages improvement science and the networked-improvement-community (NIC) design to make small, positive, systematic changes to teacher preparation programs across the United States. Enacting change within these NICs is facilitated through Plan-Do-Study-Act (PDSA) cycles. Based on an identified problem of practice, each team uses the PDSA framework to plan an intervention, do the intervention, study its implementation, and act upon those results. This poster specifies what problems of practice NICs focused on through PDSA cycles during the years 2020-2024 and the relationships between them. We created and analyzed topic patterns within a database of each PDSA cycle submitted by NICs involved in the national partnership. Results indicate specific aspects of teacher education program transformation to focus future efforts. For example, mathematical content knowledge is not a focus of PDSA cycles submitted by NICs, and an emphasis on building community within teacher preparation programs is not investigated in relation to recruitment and retention of teacher candidates. Future research should further investigate why NICs do not pair these and discuss a refocusing on program transformation.

Poster 48: Susceptibility to fatigue impacts response to biomarkers and biomechanics in Thoroughbreds

Presenter: Emily Jolley
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

Musculoskeletal injuries have been identified as the leading cause of death in racing Thoroughbreds. Fatigue is of interest as a contributing factor, as it has been shown to relate to changes in biological markers and biomechanics of exercising horses. The changes that occur between pre and post exercise were evaluated. Twelve unfit mature Thoroughbred geldings were subjected to a baseline week of standard exercise test on a treadmill. They then underwent an 8-week exercise regime of high and low intensity sessions, then completed the same test on week 9. Osteocalcin, C-telopeptides crosslaps of type I collagen, and type II collagen ELISA assays were performed. Treadmill camera data were used to evaluate stride length, stride duration, stance phase time, and swing phase time. Horses were deemed fatigue-susceptible or non-susceptible if they fatigued on the treadmill or did not, respectively. Data were analyzed (PROC mixed) in SAS 9.4, with effects of day, week, and fatigue status (significance $P \leq 0.05$). No significant differences were found for OC concentration or stride duration ($P \geq 0.05$). There was greater CTX-1 concentration in week 0 than 9 ($P \leq 0.05$). There was an interaction between week of exercise testing and fatigue status for CPII ($P \leq 0.01$), with fatigue-susceptible horses having greater concentration on week 9 than non-susceptible horses. Fatigue-susceptible horses had shorter stride length ($P \leq 0.01$). Fatigue was found to have many factors that contribute to it, and management of horses through biomarkers and biomechanics may play a role as well.

Poster 49: A Multimodal Deep Learning Approach for Sleep Stage Detection Using PPG and PSG

Presenter: Md Nahid Hasan
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Dr. Khem Poudel

Abstract:

Sleep is a fundamental and universal physiological process in human daily life. An irregular sleep cycle can lead to health issues and sleep disorders. About 33% of adults in the United States experience some sleep disorder sleep disorders are associated with cardiovascular diseases, cognitive impairments, metabolic disorders, and other chronic diseases. Sleep stage detection is crucial for diagnosing sleep disorders. Researchers are working to identify sleep disorders more accurately and efficiently using machine learning. Most researchers use a few features from specific physiological sensors and classical machine learning (ML) to detect sleep stages Only a handful of researchers have worked on sleep stage detection using deep learning Polysomnography (PSG) is widely used as the gold standard for sleep stage detection. However, this is labor-intensive, time-consuming, and costly. Recently, advances in ML and signal processing have increased the popularity of wearable sensors such as photoplethysmography (PPG) due to their ease of use. In this project, we will examine how well sleep stages can be detected from PPG and PSG separately. This examination could help to understand the feasibility of PPG for sleep stage detection. we plan to detect sleep stages from PPG and PSG data using DL methods. How well can sleep stages be detected from handcrafted features (statistical features) by leveraging NNs?

Poster 50: Investigating the role of MDM4 inactivation in response of neuroblastoma cells to WDR5 WIN-site inhibitors

Presenter: Cedra Kamel
Major: Biology
Department: Biology
Faculty Mentor: April Weissmiller

Abstract:

My thesis research focuses on neuroblastoma, the most common extracranial pediatric tumor found in children under five. It originates from neural crest cells and is usually driven by the amplification of the oncogenes, MYCN and ALK. Both of these are involved in tumor progression and are associated with poor prognosis in patients, demonstrating the need for research of new therapies. My project aims to reactivate p53 by using small molecule WIN-site inhibitors. These target the WDR5 protein, which is an N-MYC co-factor, to increase p53-dependent cell death. These inhibitors prevent transcription of WDR5 target genes and lead to an increase in p53 levels. WDR5 WIN-site inhibitors have been a focus of drug discovery efforts in blood cancers where p53 activation is well understood, with current inhibitors showing nanomolar cellular activity and oral bioavailability in mouse models. We do not know, however, the extent to which this mechanism applies to solid tumors, such as neuroblastoma. Since the reactivation of p53 is a feasible approach in neuroblastoma, and WIN-site WDR5 inhibitors have efficacy in neuroblastoma cell lines, understanding the mechanism of action for this new class of inhibitors could lead to potential therapeutics for effective neuroblastoma treatment.

Poster 51: Barriers and Opportunities for Scaling Undergraduate Science Communication Education: An Autoethnography of Communication and Science Education Scholars

Presenter: J. Hayes
Major: Biology
Department: Biology
Faculty Mentor: Dr. Liz Barnes

Abstract:

STUDY CONTEXT Undergraduate biology students discuss climate change, vaccines, and other culturally controversial science topics (CCSTs) outside of class in ways that can deepen social divides (Couch et al., 2021). Students want to communicate more effectively (Bowen et al., 2023) yet rarely receive guidance from their scientific training (Bowen et al., 2025). Teaching science communication can strengthen students' science and science communicator identity and self-efficacy (Alderfer et al., 2023). However, scaling the adoption of this instruction requires identifying barriers to implementation and strategies for overcoming them. The Science Communication Education Research Network (SCERN) fosters collaboration between science education and communication scholars to advance Science Communication Education (SciCommEd) research, and its members regularly experience the barriers that need to be understood and overcome.

STUDY DESIGN In Summer 2025, we administered an open-ended survey to 29 SCERN members—26 in science education and 3 in science communication—about how they conceptualize barriers and corresponding solutions to adopting science communication instruction in undergraduate science courses.

ANALYSES AND INTERPRETATIONS: Three researchers coded survey responses for common themes, which were member-checked for accuracy. A focused literature review identified barriers/solutions not raised by participants. SCERN members reported that instructors struggle with what, when, and how to teach science communication due to limited training, time, resources, and buy-in from faculty, administrators, and students. Proposed solutions included interdisciplinary collaboration to develop 1) science communication trainings for science educators as well as 2) science communication learning goals, instructional materials, and validated assessments—all of which integrate instruction about communication of CCSTs into science content. To garner buy-in to SciCommEd, the benefits of learning scicomm must become apparent to faculty, administrators, and students through more strategic dissemination of evidence (Bowen, et al., 2025; Shah, et al., 2022).

Poster 52: The Biological Evaluation of a Novel Set of Colchicine Binding Site Inhibitors Using A375 Melanoma Cancer Cells

Presenter: Alexis Katz
Major: Biology
Department: Biology
Faculty Mentor: Dr. April Weissmiller

Abstract:

Cancer is one of the leading causes of death throughout the world. This disease is treated using several different methods; however, chemotherapy is the most common. Chemotherapy consists of several different drugs that aim to halt cancer cell growth by targeting fundamental cell functions like DNA replication and cell division. One group of these drugs target tubulin, a fundamental protein involved in cell division. Currently, tubulin inhibitors like taxanes and vinca alkaloids face issues involving toxicity and drug resistance. Thus, new tubulin inhibitors have been synthesized that target the colchicine binding site on tubulin. These compounds known as colchicine binding site inhibitors (CBSIs) are promising future treatments as they are theorized to be less toxic and more likely to overcome drug resistance. In this study, we investigate a potential new set of CBSIs by examining the mechanism of action, functional consequence, and ability to overcome paclitaxel resistance using A375 melanoma cancer cells as a model system. As a result, we find that both CBSIs tested halt cells in mitosis, alter intracellular microtubule dynamics, and inhibit colony formation—an effect that was true in non-resistant and resistant A375 cells. In all, these compounds function in a manner consistent with tubulin inhibitors and should be considered for future studies aimed to characterize their potential as an effective anticancer therapy.

Poster 53: Exploring how General Biology and General Chemistry Students Perceive Themselves within the Context of Their Definitions of a Science Person and a Scientist

Presenter: Mera Ishak
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Katy Hosbein

Abstract:

While science identity and its relation to student retention in science majors have been widely studied, there is still a need for a more precise exploration of how students define the terms “science person” and “scientist.” Building on previous preliminary findings, this project expands the dataset to examine how students see themselves within these definitions. Understanding how students view themselves in these roles provides insight into the development of their science identity and informs the design of learning environments and teaching practices that support this growth. Students enrolled in General Biology and General Chemistry, known as “gateway courses,” were chosen for this study. These courses are typically a student’s first introduction to the field of science, and a student's experience within these courses can be the deciding factor when it comes to continuing in or leaving science. To obtain student responses, surveys created using Qualtrics were sent by email. In these surveys, students were asked to select a response ranging from strongly disagree to strongly agree for two statements: “I see myself as a science person” and “I see myself as a scientist” and then explain their choice. Student responses were coded using Descriptive Coding, a way of summarizing qualitative data into short phrases and aligned with the constructs of James Paul Gee’s (2000) identity framework. Four themes were identified through thematic analysis: strong science identity (theme 1), developing or uncertain science identity (theme 2), limited science identity (theme 3), and inconsistent science identity expression (theme 4). How students view themselves within these themes will be presented. This project contributes to understanding student science identity and offers insight into supporting its development and promoting retention within the field of science.

Poster 54: A Multivariate Spatial Analysis and Logistic Regression-Based Model of Hurricane Helene Landslide Induction Sites

Presenter: Emily Keiningham
Major: Geosciences
Department: Geosciences
Faculty Mentor: Todd Moore

Abstract:

Landslide prediction modeling relies on spatial and numerical modeling. Case studies of major landslide events can lead to predictive mapping, which in turn informs regions of high susceptibility zones and allows more accurate risk analysis. Using geospatial analysis and a logistic regression, the landslides from Hurricane Helene were assessed in reference to various environmental, geographic, and anthropogenic variables to then create descriptive statistics and a susceptibility map. The model was found to categorize ~60% of pre-Helene landslides in increased-risk zones and ~35% of Helene landslides in average or increased risk zones. Environmental analysis showed a significant reduction in susceptibility with increased tree cover and associations between slope, soil type, and hazard hangover with landslide activation.

Poster 55: Mitigating the Privacy–Utility Paradox with Quantum Gradient Hiding

Presenter: Clifford Jones
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Dr Khem Poudel

Abstract:

Federated learning (FL) trains models across multiple data owners without pooling raw records, but it can still leak information because the server may observe per-client updates. This creates a privacy--utility paradox: client-level differential privacy (DP) can reduce gradient leakage by clipping and adding noise, yet privacy-relevant noise levels often reduce accuracy. We study a complementary approach based on \emph{aggregate-only observability}, where the server is prevented by design from accessing individual client updates and can observe only an aggregate update each round.We implement an apples-to-apples pipeline comparing baseline FL with per-client update visibility, DP-FL with client clipping and Gaussian noise, sum-only aggregation (\texttt{hide_sum}) that preserves the aggregate learning signal while hiding per-client updates, and a quantum-inspired sum-only mode (\texttt{qsum}) in which the server receives only a finite-shot estimate of an aggregate update. Utility is measured by the test area under the ROC curve and privacy is assessed using gradient inversion-style reconstruction similarity.In Texas PUDF (61 clients) and a MIMIC-IV ICU prediction task (3 clients), sum-only training preserves baseline utility (Texas AUC 0.7807 ± 0.0191 vs.\ 0.7831 ± 0.0181; MIMIC AUC 0.8578 ± 0.0142 vs.\ 0.8525 ± 0.0127). DP settings that substantially reduce reconstruction similarity (e.g. noise $\sigma=0.2$) incur a clear utility cost (Texas AUC 0.6920 ± 0.1367; MIMIC AUC 0.7629 ± 0.0567). \texttt{qsum} matches or slightly improves utility at 20k shots (Texas 0.8040 ± 0.0163; MIMIC 0.8623 ± 0.0137) and supports a transparent resource--performance discussion via shot and grouping sweeps. Overall, restricting server observability to aggregates maintains utility while shrinking the per-client attack surface, and quantum sum-only primitives provide an enforceable pathway toward aggregate-only learning in future secure FL systems.

Poster 56: Life Cycle Assessment (LCA) of plastics, capabilities and deficiencies

Presenter: Marie Lowell
Major: Engineering Technology
Department: Engineering Technology
Faculty Mentor: Mina Mohebbi

Abstract:

Plastics production began in 1907 to replace natural materials that were becoming scarce; they created an economic and practical solution for various industries with their light, durable, and cost-effective materials. With the breadth of new research on plastics, their initial positive quality of being durable has quickly turned on its head. Their inability to degrade has caused immense damage to ecosystems, humans, and our physical environment. Plastics in our soil leach harmful chemicals and microplastics disrupting soil health and fertility. Similarly, plastics in water resources also leach harmful chemicals, causing water contamination and harmful aquatic ecosystems. Life Cycle Assessment (LCA) is a decision-making tool that can help select and optimize technical solutions by evaluating the environmental impacts of plastic from raw material extraction to the end of life. There are multiple databases that collect such data. The US Environmental Protection Agency created the WARM (Waste Reduction Model), a database that estimates potential greenhouse gas emissions, energy savings, and economic impacts of solid waste management practices. WARM highlights six waste management practices: source reduction, recycling, composting, anaerobic digestion, combustion, and landfilling. Of the 7 types of plastic manufactured worldwide, WARM collects and provides data on HDPE, LDPE, LLDPE, PET, PP, PS, PVC, and Mixed Plastics. Existing plastic LCA's are limited due to the lack of input data for the Environmental Impacts of plastics, such as the effects of microplastic contamination in soils, marine life, and biodiversity. Limitations are also found in Plastic LCA's due to the lack of coverage of additives in plastic products, with numerous constituents that cannot be generalized by an LCA. Also, some LCA's fail to include the End-of-Life phase which results in skewed, incomplete data. This study aims to evaluate the status of LCA's for plastics, identifying knowledge gaps, and offering potential improvements among databases.

Poster 57: Shiitake and Algal Proteins Mimicking Beef Fat through Emulisions

Presenter: Anna Kosinski
Major: Fermentation Science
Department: Agriculture
Faculty Mentor: Dr. Anto Charles

Abstract:

Excess intake of saturated fat has been the major cause of chronic disease conditions. This research revealed the strategy for fabricating fat substitutes using spirulina-derived single-cell proteins (SSCP) and Tennessee-grown shiitake fruiting biomass (SFB) or protein (SFP). Our findings revealed that gels stabilized using SSCP and SFB form relatively stable fat substitutes compared to those stabilized using SSCP and SFP, as evidenced by higher G' and G". The SSCP-SFB gels demonstrated superior physical stability for 65 days at 4 °C and 25 °C, as well as high freeze-thaw stability.
The structural analysis of SSCP-SFB gels revealed the formation of protein aggregates, with major bands observed at 43-52 kDa and 7-14 kDa. Fourier transform spectroscopy revealed new peaks at 1676 cm*' attributed to protein aggregate formation in the gels, and minor peak shifts around 1643 cm''. Confocal microscopy analysis of SSCP-SFB gels revealed the distribution of protein aggregates, with micro-and nanoclusters surrounding the oil droplets. Consequently, increasing the SSCP-to-SFB ratio from 1:1 to 3:1 resulted in smoother oral sensation and greater creaminess.
Tribological analysis revealed a disintegrating pattern of the gel bolus at increasing sliding speed, accompanied by a shift from mixed to boundary regime, similar to that observed with beef fat. The present research suggests that algal single-cell protein and shiitake fungal biomass can produce fat substitutes with comparable oral lubrication properties to those of beef fat.

Poster 58: Using LLMs in the Mathematics Classroom

Presenter: Ivan Lozano
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Jeremy Strayer

Abstract:

Artificial intelligence (AI) advancements have impacted many facets of education, among them how students engage with mathematics. As an academic disruptor, AI presents opportunities and challenges for instructional reform (Rupnow et al., 2020). As AI-mediated instructional methods are innovated, it is important to examine their internal coherence and viability under controlled conditions before implementing them in the classroom (UNESCO, 2023). This poster presentation will introduce a proof-of-concept investigation of one possible method, where students create and refine their own definitions of mathematical objects through dialogue with a large language model (LLM). Prior work has explored LLMs' capabilities to generate mathematical explanations or examples (Gupta et al., 2025), but few studies have investigated how AI-mediated dialogue can foster student-generated mathematical definitions. With this context, we developed a prompt-structured task and investigated how iterative interaction with LLMs might support students in creating and refining definitions of mathematical objects in a classroom setting. The study evaluated how students addressed potential student inputs, focusing on (1) which features of a simulated LLM definition-refinement conversation were associated with producing an improved definition, and (2) in simulated LLM definition refinement conversations using a questioning feedback strategy, how the question type is associated with the likelihood of an improved definition. Findings from this study showed that students were far more likely to improve their definitions when refining with ChatGPT than with Gemini or Copilot. This task was put into practice with a class of preservice elementary and high school teachers learning geometry and functions. Students responded variably to the task structure, revealing both benefits, such as reflective practices, and limitations, such as accessibility issues and prompt fatigue. Despite those challenges, this pilot study shows that LLMs can be effective tools for promoting conceptual understanding in mathematics.

Poster 59: Comparison of various sealing methods during one day of loaded testing with the Tekscan Hoof System

Presenter: Marci Leath
Major: Animal Science
Department: Agriculture
Faculty Mentor: Alyssa Logan

Abstract:

Quantifying force distribution of the equine solar hoof can be accomplished through the Tekscan Hoof System, which records hoof force and area loading on horse hooves during movement. Four pairs of Tekscan Hoof Sensors were trimmed to the shape and size of glue-on horseshoes and placed in the shoe for simulated arena testing, not worn on a horse. Sensors were treated with sealing materials, with 2 replicates per sealing type: adhesive neoprene, liquid silicone, Gorilla Tape, and no sealing (control). The study was performed in a clay-based arena. Static loading was recorded after placing a known weight upon each sensor, while cyclic loading was recorded through manually applying pressure to the sealed sensor, mimicking steps of a horse. Sensors reported area loaded and force applied in each recording. Data were collected at time intervals of 07:00, 10:30, and 14:00. This study will provide further insight into the reliability of Tekscan Hoof Sensors, influencing future methods of data collection for research of the equine hoof. Data were analyzed with SAS 9.4. The normal force decreased throughout data collection time intervals when loaded in both a static ($P < 0.001$) and cyclic ($P < 0.001$) manner. During static loading, taped sensors allowed for the greatest transmission of normal force across all sealing methods ($P < 0.001$), but foam sealing allowed for greatest area transmission ($P < 0.0001$). During cyclic loading, taped sensors maintained the greatest transmission of normal force across all sealing methods, while foam and painted sealing had the least normal force ($P < 0.0001$). Foam sealing continued to allow for the greatest loaded area transmission ($P < 0.0001$) under cyclical loading. The preferred sealing method may depend on the prioritized measurement for evaluation, as well as the load being applied.

Poster 60: Metabolites of an emerging fungal pathogen alter snake-skin microbiome assembly

Presenter: Tatyana Martinez
Major: Biochemistry
Department: Biology
Faculty Mentor: Dr. Donald Walker

Abstract:

Emerging fungal diseases pose an increasing threat to global biodiversity. Ophidiomyces ophidiicola, a keratinophilic fungal pathogen, is the causative agent of ophidiomycosis, an emerging fungal disease affecting snake populations across North America and Europe. The skin serves as a physical and chemical barrier to cutaneous pathogens, and harbors a unique microbiome that also contributes to nonspecific host immunity. However, O. ophidiicola exhibits strong keratinase activity, capable of altering the metabolic niche space available to resident microbial communities, resulting in pathogen-induced dysbiosis (PID) on wild snakes. PID is characterized by reduced bacterial richness and increased community dispersion of the microbiome. As PID increases with O. ophidiicola loads, understanding how a gradient of fungal metabolized resources (i.e., niche space) and the resulting fungal metabolites influence the skin microbiome provides a link between disease progression and the host microbiome. To assess how the microbial community responds across the progression of ophidiomycosis, we established a stable community on a keratin minimal media, which reflects the composition of snake skin, in the absence of fungal resource use and exometabolite production. Afterwards, we then exposed stabilized snake skin bacterial communities to O. ophidiicola spent media representing degrees of resource use and metabolite production at 5 and 10 days. These days reflect a decline in keratin resource availability and an increase in fungal metabolites over time. With this study design, we characterized how the bacterial community shifts in response to a gradient of fungal niche alteration. The goal of this project is to better understand how O. ophidiicola metabolism of snake skin drives PID, informing future functional characterization of these shifts in host-pathogen resistance and contributing to targeted conservation efforts.

Poster 61: Tracking Particles Through Time: How Sediment Size Relates to River Conditions

Presenter: Julie Lewis
Major: Geosciences
Department: Geosciences
Faculty Mentor: Dr. Galina Shinkareva

Abstract:

Turbidity is commonly used as an indicator of water quality because it reflects the amount of suspended sediment present in the water column. However, turbidity does not act independently. It responds to the same hydrologic processes that influence other water quality parameters. This study examines how dissolved oxygen (DO), pH, and specific conductivity vary alongside turbidity under changing flow conditions within a river system.

Field measurements of turbidity, DO, pH, and conductivity were collected concurrently with sediment particle size analyses to evaluate how sediment mobilization and water chemistry respond to hydrologic variability. Periods of increased discharge and runoff are expected to elevate turbidity due to sediment entrainment, particularly fine-grained material that remains suspended for longer durations. These higher flow conditions may also enhance dissolved oxygen through increased turbulence and atmospheric mixing, while lower flow conditions may allow settling and reduce mixing efficiency.

Changes in pH are evaluated in relation to sediment input and runoff, as soil-derived materials and organic matter can influence short-term shifts in acidity and buffering capacity. Specific conductivity provides additional insight into dissolved ion concentrations and may decrease during runoff events due to dilution, even as turbidity increases from suspended sediment transport.

By analyzing these parameters together rather than in isolation, this research aims to better characterize how physical sediment dynamics and water chemistry co-vary in response to hydrologic forcing. Understanding these relationships supports more comprehensive interpretation of water quality variability in dynamic river systems.

Poster 62: Fusing the Two Subunits of Bacterial Luciferase into a Single-Gene Biological Reporter

Presenter: Julie Mehany
Major: Biology
Department: Biology
Faculty Mentor: Dr. Robertson

Abstract:

The bacterial luciferase enzyme is a heterodimer that produces visible light encoded by the luxA and luxB genes. In the 1990's, others fused these subunits into a single gene, encoding one continuous protein, however with sub-optimal luminescence. We have used the crystal structure of the heterodimer to engineer a fusion of these two genes in a way that may produce a more functional enzyme. This project compares the luminescence of the 1990's construct with our newly engineered variant by introducing these genetic constructs into E. coli and testing their cultures' luminescence. The results demonstrated that our variant produced three times more luminescence than the 90's version, but still dimer than the native heterodimer. Our single-gene luciferase is a promising candidate for use as a biological reporter. Going forward, we will test our single-gene luciferase in mammalian cell lines.

Poster 63: Examining How Science Norms and Mentorship Shape First-Generation College Students' Motivation, Science Identity, and STEM Persistence

Presenter: Tomi Mafe
Major: Mathematics and Science Education
Department: Chemistry
Faculty Mentor: Dr. Kathryn Hosbein

Abstract:

First-generation college (FGC) students are defined as students whose parents or caregivers did not complete a four-year degree. FGC students enter STEM with distinctive cultural assets yet face structural and cultural barriers to belonging and persistence in STEM disciplines. The development of science identity involves both demonstrating competence and recognition and participation within the science community (Robinson et al., 2020; Robnett et al., 2018). Mentoring relationships are central to this interpretive process and can either reinforce or interrupt exclusionary norms (Atkins et al., 2020). This study examines FGC students' experiences in chemistry and biology through two research questions: (1) What science community norms do FGC students perceive as emerging through their mentoring relationships? and (2) What forms of community cultural wealth do FGC students draw upon to navigate science norms and persist in chemistry and biology pathways?

Participants in this study are junior and senior FG chemistry and biology majors at Middle Tennessee State University. Semi-structured interviews explored perceptions of science culture, mentoring experiences, belonging, workload, and academic navigation. Data were analyzed using thematic analysis (Braun & Clarke, 2006), integrating theoretically informed coding.

Findings reveal that students often experience science as performance-driven, stressful, and structured around implicit expectations. Norms such as self-reliance, limited guidance, and overwork were frequently transmitted through mentoring interactions. In some cases, mentoring reproduced gatekeeping dynamics by normalizing ambiguity and high productivity without structural support. In many cases, mentoring reinforced exclusionary norms by normalizing high productivity, limited guidance, and implicit expectations, thereby intensifying students' feelings of marginalization and self-doubt. Rather than assimilating into dominant norms, students described persisting by mobilizing aspirational, navigational, social, and familial capital, consistent with Community Cultural Wealth theory (Yosso, 2005).

These findings position mentoring as a critical site where science norms are interpreted, negotiated, and reproduced. The study calls for asset-based mentoring practices and institutional reflection on how departmental norms shape first-generation students' science identity and long-term persistence in STEM.

Poster 64: A Plasma-Based Remediation Strategy for PFAS and Co-Contaminants in Complex Matrices

Presenter: Mahmudun Noby
Major: Chemistry
Department: Chemistry
Faculty Mentor: Dr. Chong
Co-Presenters: Edmund Zhu, Ngee Sing Chong, and Beng Guat Ooi

Abstract:

PFAS chemicals, known as "forever chemicals," are hard to destroy because of their strong carbon-fluorine bonds. Common treatment methods often just move them from water to filters, creating concentrated waste that needs expensive disposal.
This study tested a different approach: using extremely high-temperature plasma to destroy a PFAS called PFOA. Instead of just moving the pollution, the goal was to break it apart completely. The PFOA-contaminated water was turned into mist and shot into a plasma torch reaching 7,000 to 10,000 Kelvin. At this heat, the PFOA molecules should break down into their basic elements.
To understand what happened, the researchers studied the gases coming out of the plasma in several ways. They passed the gas over aluminum powder, bubbled it through different liquids, and captured samples in bags for detailed testing.
The results were promising. Tests on the aluminum powder showed it had reacted with fluorine from the PFOA, creating aluminum fluoride. This proved the PFOA was destroyed and the fluorine was captured. Bubbling the gas through liquids also captured fluorine and other elements. Importantly, tests confirmed that PFOA itself was completely gone from the gas. While some new, smaller molecules formed, no new PFAS chemicals were created.
The research shows that high-temperature plasma can effectively destroy highly concentrated PFOA waste. It breaks the strong chemical bonds and turns dangerous "forever chemicals" into harmless minerals that can be captured. This suggests plasma technology could be a powerful, sustainable way to eliminate these tough pollutants instead of just storing them. The method successfully mineralized PFOA without producing harmful by-products, offering a promising solution for treating high-concentration PFAS waste streams.

Poster 65: Using the Peptoid Library Agar Diffusion (PLAD) Assay to Discover New Antimicrobial Peptoids Against Pseudomonas aeruginosa.

Presenter: Elena Mancera Andrade
Major: Molecular Bioscience
Department: Chemistry
Faculty Mentor: Kevin Bicker

Abstract:

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.

Poster 66: Understanding Student Thought Processes in General Chemistry and Introductory Physics

Presenter: Emily Olson
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Dr. Hosbein and Dr. Phelps

Abstract:

Introductory chemistry and physics are foundational to building students' knowledge and problem-solving skills that they will use throughout their time in college. However, students often struggle to apply their conceptual knowledge and mathematical skills to problems. As such, there appears to be a disconnect between what students know about content and how they solve problems. This project aims to help clarify this disconnect in knowledge and application. To do this, think aloud interviews were conducted with students where students worked through problems while explaining each step in their thought process. Questions were formulated from sources such as the Group Assessment of Logical Thinking, the Force Concept Inventory, and chemistry textbooks. Students were asked questions about both chemistry and physics topics, and introductory students and upper division students were both interviewed with the same set of questions. These interviews were then analyzed to determine the method that students think through the problem, specifically in terms of pattern recognition and proportional reasoning. These results will then hopefully be formulated into a plan that can be used by professors to adjust teaching strategies to increase student success. Future work will also hope to connect these results to common misconceptions that students have in these classes.

Poster 67: Comparative Evaluation of Federated Learning Algorithms Under Varying Levels of Statistical Heterogeneity

Presenter: Safal Marahatta
Major: Computer Science
Department: Computer Science
Faculty Mentor: Joshua L. Phillips

Abstract:

Federated learning (FL) enables collaborative model training across distributed clients without sharing raw data, but statistical heterogeneity—where data distributions vary across clients—remains a major challenge. Several algorithms have been proposed to address this issue, yet existing comparative studies typically rely on standard benchmarks like MNIST and CIFAR-10 and do not evaluate all major FL algorithms across diverse data modalities under systematically varied heterogeneity levels. This study presents a comprehensive evaluation of six federated learning algorithms—FedAvg, FedProx, SCAFFOLD, FedAdam, FedYogi, and FedDyn—across three datasets representing distinct data modalities: Forest Cover Type (tabular), Diabetic Retinopathy (medical imaging), and Food-101 (natural images). Data heterogeneity is simulated by partitioning each dataset among 10 clients using a Dirichlet distribution with α values of 0.1 (high non-IID), 0.5 (moderate non-IID), and 1.0 (near-IID). Algorithm performance is assessed using four metrics: final accuracy, accuracy gap relative to a centralized baseline, convergence behavior across communication rounds, and client accuracy variance. Preliminary results using FedAvg on the Forest Cover Type dataset confirm that performance degrades as heterogeneity increases, validating the experimental setup. This study aims to reveal whether algorithm performance remains consistent across modalities or whether certain algorithms are better suited to specific data types and heterogeneity conditions, offering practical guidance for real-world federated learning deployments.

Poster 68: Structure-Guided Adaptive Sparse Generalized Additive Models

Presenter: Hannah Osborne
Major: Mathematics
Department: Mathematics
Faculty Mentor: Dr. Donglin Wang

Abstract:

Generalized Additive Models (GAMs) offer an attractive balance between predictive flexibility and interpretability, yet their performance often degrades in high-dimensional settings with correlated predictors and complex interactions. This project proposes Structure-Guided Adaptive GAM (SG-AdaGAM), a novel framework that improves predictive accuracy while preserving interpretability. The model integrates (1) group-adaptive sparsity penalties, (2) adaptive interaction selection, and (3) dynamic penalty scheduling to regulate model complexity. SG-AdaGAM is evaluated against established baselines, including standard GAMs, Elastic Net, Random Forests, Neural Additive Models, and Explainable Boosting Machines. Experiments on regression and classification datasets from the UCI Machine Learning Repository assess predictive performance and interpretability. The results aim to identify scenarios where structure-guided adaptive modeling provides measurable advantages for interpretable machine learning.

Poster 69: Assessing the Role of Horse Demographics in Intercollegiate Draw-Based Equestrian Competition

Presenter: Haley Maro
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

The Intercollegiate Horse Show Association (IHSA) provides equestrian competition opportunities for college and university students regardless of riding level, gender, race, or financial status. The IHSA includes forty regions across eight zones, representing more than four hundred institutions and over ten thousand members. The competition format is draw based - riders compete on a horse assigned at random and are judged on equitation and horsemanship, including position, effectiveness, and communication with the horse. Due to this, compatibility within the draw system is essential. Similar formats are used by the Interscholastic Equestrian Association (IEA) and the Youth Equestrian Development Association (YEDA). This study aims to evaluate the horse demographics within intercollegiate draw based equestrian competition and determine whether certain characteristics influence competitive outcomes. Our hypothesis is that horses that are owned by a university may accrue more points per ride than non-university owned horses. Research will take place at the 2026 IHSA National Horse Show. Data will be collected through surveys and in-person assessment. Survey data will include ownership status, age, and breed. In-person measurements will include weight, height, and body condition score. Additional variables recorded by Middle Tennessee State University researchers will include crop and/ or spur options and class placings. Placings will be converted to point values (10 points for first, 9 for second, 8 for third, etc.) and averages to calculate points per ride for each horse. Statistical analyses will identify relationships between horse demographics and competitive results. Findings will provide insight into the IHSA draw system and other similar organizations, supporting evidence-based decisions to enhance fairness in competition. Results will be presented at the 2027 Equine Science Society Meeting and shared with the IHSA board. Finally, results will be submitted for full publication with an appropriate journal.

Poster 70: Mindset Interventions for Elementary Preservice Teachers to Support Positive Beliefs about Overcoming Academic Challenges in a Mathematics Content Course

Presenter: Sarvani Pemmaraju
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Dr. Alyson Lischka

Abstract:

Preservice teachers (PSTs) face challenges with mathematics content, beliefs about mathematics, and beliefs about mathematical abilities. To help PSTs overcome these challenges and foster their beliefs about overcoming challenges, this design-based dissertation research focuses on wise mindset interventions (Walton & Wilson, 2018). The purpose of this study is to understand PSTs' academic challenges in an introductory mathematics content course and how wise interventions can help overcome challenges. Data sources include PSTs' self-reported qualitative surveys used as wise interventions, classroom observations, audio interviews, and student artifacts. Data was analyzed qualitatively and codes were determined using open thematic analysis (Braun & Clarke, 2006). Coding was conducted in iterations by revisiting and refining to determine broader themes and to improve robustness of findings.

Poster 71: Vibrational Spectroscopy and GC-MS Methods for Detecting Ignitable Liquids in Burned Carpet Debris

Presenter: Mikayla Miles
Major: Chemistry
Department: Chemistry
Faculty Mentor: Ngee Sing Chong

Abstract:

When a fire occurs, one of the first things to be determined is whether there is suspicion of arson at the scene. Investigators typically begin by using Accelerant Detection Canines (ADCs) to detect the presence of an accelerant, such as gasoline, paint thinner, or diesel. Once a positive alert has been made, the investigator will collect a sample for analysis with a gas chromatography-mass spectrometry (GC-MS) instrument. GC-MS is traditionally used because it can analyze arson debris and can identify specific classes of ignitable liquids (ILs) used in arson cases. Preliminary results indicate that hydrocarbons present in ILs were degraded through the oxidative combustion of exposed carpet material, but were preserved in unexposed carpet material under heavy objects or furniture. Our results support the idea that ILs can seep beneath heavy objects and undergo vaporization and pyrolysis rather than undergo oxidative combustion due to the lack of oxygen. This process preserves the hydrocarbons essential for IL identification.

The goal of our research is to use GC-MS and infrared spectrometric methods to distinguish the chemical profiles of exposed, burned carpet material from those of unexposed, thermally affected carpet material subjected to weights simulating heavy objects or furniture. The weights are a stack of paver stones placed on a piece of carpet, leaving about 3 by 12 inches of exposed carpet area for burning with different ignitable liquids. Once the burn is conducted, exposed and unexposed carpet samples will be collected and prepared for headspace and solvent extraction methods for analysis with GC-MS, Fourier Transform Infrared spectroscopy (FTIR), and Raman spectroscopy. Using multiple instrument techniques will allow arson investigators to explore their complementary nature and enhance the feasibility of headspace analysis for residual ignitable liquids in the carpet debris.

Poster 72: Are we Preparing Biology Students to Talk About Vaccines? Exploring Student Perspectives

Presenter: Travis Ray
Major: Biology
Department: Biology
Faculty Mentor: M. Elizabeth Barnes

Abstract:

I am exploring undergraduate biology students' vaccine attitudes and experiences with vaccine communication and vaccine education to provide recommendations for improving vaccine education. My research questions are: What are undergraduate biology students' current knowledge, attitudes, and beliefs about vaccines? How are undergraduate biology students communicating with others about vaccines? In what ways are undergraduate biology students learning about vaccines in their biology courses, and how do they think vaccine education can improve?

To prepare students for having careers in science and healthcare, biology scholars identified that students need science knowledge and the ability to communicate science. Despite being regarded as a key competency of the undergraduate biology curriculum, the teaching of science communication is largely absent from these programs, and even more so within the teaching of communicating culturally controversial science topics (CCSTs). Vaccines are an example of a CCST, as scientists recognize vaccines as an important medical advancement, yet vaccines also carry mistrust within the public. It is important for biology educators to have information on student knowledge, attitudes, and communication about vaccines so they can implement effective instruction. However, educators currently lack this information.

I am recruiting 30 participants to participate in 60-minute semi-structured interviews. Prior to interviews, participants will complete a pre-interview survey that gauges their vaccine knowledge & education history. Interviews will be audio-recorded and transcribed. Inductive and deductive content analysis with constant comparison methods will be used to identify themes, and I'll create a codebook to describe these themes. A second researcher will analyze a subset of interviews to determine the codebook's interrater reliability

Currently, I have conducted eight interviews. Although data are preliminary, participants infrequently communicate vaccines due to feeling underprepared. Participants feel underprepared with communicating vaccines given their lack vaccine instruction in biology courses. However, participants display positive attitudes towards vaccines.

Poster 73: Exploring the Role of MYC in a SMARCA4-deficient Cancer, Small Cell Carcinoma of the Ovary, Hypercalcemic Type

Presenter: Amelia Mitchell
Major: Molecular Bioscience
Department: Biology
Faculty Mentor: Dr. April Weissmiller

Abstract:

The SWI/SNF chromatin remodeling complex is mutated in ~20% of cancers, including small cell carcinoma of the ovary hypercalcemic type (SCCOHT) and about 10% of non-small cell lung cancers (NSCLC). One potential mechanism of tumorigenesis in these cancers involves dysregulation of the major oncogene MYC. MYC, which encodes the MYC protein, is overexpressed or dysregulated in over 50% of cancers. As a transcription factor, MYC regulates a diverse set of cancer-causing genes involved in processes such as cell growth, proliferation, and metabolism. Recent studies show that in SCCOHT, MYC target gene signatures are activated, and that MYC positively regulates the expression of DNA repair genes, which is suggested to compensate for the replicative stress MYC induces during cell division. However, it is still unclear how broadly significant these findings are and whether the mechanisms identified in SCCOHT can be applied to SMARCA4-deficient NSCLC. Furthermore, since tumor suppressors cannot easily be replaced in cells, and MYC is considered "undruggable", understanding the mechanisms underlying tumorigenesis in these cancers could uncover alternative therapeutic targets. Here, we investigated the role of MYC in a SCCOHT cell line engineered to express a version of MYC that can be acutely depleted from cells through addition of a degrader molecule. We characterized how MYC depletion affects SCCOHT function using a combination of approaches. We found that depletion of MYC decreases cell proliferation with a concomitant increase of cells in G1-phase of cell cycle and that MYC depletion also decreases the expression of conserved MYC target genes. Intriguingly, we find that proteins involved in DNA damage and repair decrease in response to loss of MYC, supporting the function of MYC in promoting both replication stress and DNA repair. These results lay a foundation for further investigation into the role of MYC and SWI/SNF in these deadly cancers.

Poster 74: Relationship Between the Antibiotic Resistance Gene SHV and Biodiversity in the Stones River Watersheds

Presenter: Eliana Rumberg
Major: Biology
Department: Biology
Faculty Mentor: Dr. Cole Easson

Abstract:

Antibiotic resistant genes are an increasing problem in modern medicine. These genes can be found in local waterways, where they become a source of resistance for other bacteria. SHV is a type of enzyme that usually has an encoded plasmid that is commonly antibiotic resistant. SHV is the antibiotic resistance gene that was tested for in the Stones River Watershed. The presence or absence of the SHV gene was determined for 10 different sampling sites. This presence data was compared to the diversity and richness of the species detected at the sites by environmental DNA. After collecting two, one-liter samples from each site, the presence or absence of SHV was determined by amplifying the SHV gene using polymerase chain reaction and running the product using gel electrophoresis. It was found that exactly half of the samples showed the presence of SHV across the sites with variability in whether SHV was detected in both samples from a single site. When comparing the presence/absence of antibiotic resistance and the diversity of species collected, there were no major correlations found. Overall, sites with the SHV gene present had the same average diversity and richness as those without the antibiotic resistant SHV gene.

Poster 75: Bioaffinity-Driven Cipher Key Generation for Symmetric Encryption

Presenter: Jaleigh Morales
Major: Molecular Bioscience
Department: Chemistry
Faculty Mentor: Jan Halamek

Abstract:

Bioaffinity interactions offer a novel strategy for cryptographic key generation by utilizing the unique outputs of enzymatic reactions. In this proof-of-concept study, enzyme–substrate interactions were used to generate measurable biochemical signals that were transformed into cipher keys for symmetric encryption. The American Standard Code for Information Interchange (ASCII) encoding framework enabled integration of these biologically derived keys into digital message encryption and decryption workflows. To enhance security and restrict unauthorized key generation, a PIN-based validation step was incorporated to produce the correct signal output for cipher key generation. When two authorized users perform identical experimental protocols under controlled conditions, equivalent biochemical outputs are produced, allowing generation of matching symmetric keys for encryption and decryption.

The variation of assay parameters, including enzyme and substrate concentrations, buffer pH, and detection wavelength, provides tunable complexity and reduces risks of key repetition or predictability to address common challenges in cryptography. Additionally, character encoding was used to integrate modern technology with this cryptographic system in sending and receiving encoded messages.

This interdisciplinary approach integrates biochemical assay design with modern cryptographic principles, demonstrating a multicomponent system for secure key generation and authentication. This research seeks to advance methodologies that leverage unique biochemical outputs for the generation and secure management of encryption keys. By harnessing the inherent variability and complexity of bioaffinity interactions, this work holds promise for novel mechanisms for key generation in a broad application of cryptographic systems.

Poster 76: Host phylogeny and ecology jointly structure reptile and amphibian gut bacteriomes and mycobiomes

Presenter: Alexander Rurik
Major: Molecular Bioscience
Department: Biology
Faculty Mentor: Donald Walker

Abstract:

Gut microbiomes influence host nutrition, immunity, and overall health, yet broad-scale tests of how host evolution and ecology structure gut communities in wild vertebrates have focused disproportionately on mammals and birds. Reptiles and amphibians (herpetofauna) span deep evolutionary timescales and exhibit diverse diets and life histories, providing a powerful system to evaluate drivers of gut microbiome assembly, test for phylosymbiosis, and determine how ecological and geographic factors modify host–microbiome associations. Moreover, most vertebrate gut microbiome studies remain bacteria-centric, despite potential bacterial-fungal interactions and emerging evidence that fungi such as Basidiobolus may be widespread in herpetofaunal guts. Here, we characterize gut bacterial (16S rRNA v4) and fungal (ITS1 rDNA) communities from 198 reptile and amphibian species from across the United States, including predominantly wild individuals, using absolute abundance-corrected amplicon sequence data generated using our newly developed DspikeIn approach. Across hosts, bacterial communities were dominated by Firmicutes and Bacteroidota, while fungal communities frequently included Basidiobolomycota and Ascomycota alongside other early-diverging fungal lineages. Ordination and permutation-based analyses indicated host phylogeny explained the largest share of variation in both kingdoms, with diet and other ecological factors contributing smaller effects. After controlling for geographic distance, bacterial community dissimilarity remained strongly associated with host phylogenetic distance in both amphibians and reptiles, consistent with broad bacterial phylosymbiosis. In contrast, fungal patterns were clade- and context-dependent: amphibians showed detectable phylogenetic structuring, whereas reptile fungal communities were more strongly associated with geography in the wild and showed only weak phylogenetic signal under managed conditions. Together, these results support consistent bacterial phylosymbiosis across herpetofauna while highlighting greater environmental contingency in gut fungal communities.

Poster 77: Paths to Recovery: Unmounted and Mounted Equine Assisted Services (EAS) for Veterans

Presenter: Karly Moreno
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

Veterans often sacrifice to serve their country, not knowing how their time in service transforms them and with minimal foresight on their return to civilian life. Many may struggle with reintegration into civilian society and feel a sense of loss both of their community and of their sense of purpose. With many veterans struggling with mental health and reintegration issues, Equine Assisted Services (EAS) have gained recognition as an alternative to a traditional therapeutic approach. The objective of this study is to compare the efficacy of unmounted and mounted equine programs for veterans through mental health assessments. With the increased popularity of Equine Assisted Services for veterans, this research intends to evaluate if mounted and unmounted formats can provide meaningful benefits for veterans and potentially increase accessibility to EAS for veterans in communities with limited resources available. This study will recruit 40 veterans who are divided into mounted and unmounted groups to evaluate program effectiveness. Participants will complete a 10-week program conducted at Middle Tennessee State University (MTSU) with support from students enrolled in the Center of Equine Recovery for Veterans (CERV) course. Both unmounted and mounted programs begin with basic horse care activities, including tying, grooming, and leading. At week five, the mounted group progresses to riding and basic horsemanship, while the unmounted group focuses on connection and groundwork. Participants will be assessed using the Generalized Anxiety Disorder-7 (GAD-7), Patient Health Questionnaire-9 (PHQ-9), and World Health Organization's Quality of Life – Short Form Assessment (WHOQOL-BREF) at weeks 0, 5, and 10. Subjective Units of Distress (SUDs) scores (1-10) are recorded before and after each session. It is anticipated that unmounted and mounted programs both have the capability to lead to improvements in a veteran's mental wellbeing and quality of life as perceived through self-surveys.

Poster 78: Assessment of Sinkhole Flooding Conditions in Murfreesboro, TN Using Dove Satellite Imaging, Hydrograph and Precipitation Data, ArcGIS, and LiDAR Elevation

Presenter: Grace Sandidge
Major: Geosciences
Department: Geosciences
Faculty Mentor: Dr. Mark Abolins

Abstract:

In the Shores Rd and Steelson Way focus area located in Murfreesboro, TN, sinkholes flood after heavy rain (Abolins and Ogden, 2023). Recent observations of the March 28, 2021 and May 9, 2024 storms were made using Dove satellite images and ArcGIS, which allows for comparisons to be made with a May 2010 Google Earth image and Abolins and Ogden's (2023) maps of February 2020 flooding. Based on these observations, I found that there is less flooding in 2024 compared to 2021, 2020, and 2010 despite high flow on the Stones River and post-2021 urbanization. Satellite images and delineated topographic depressions from the May 2024 storm event show that inundation is less widespread. Causes of reduced flooding are being investigated.

Poster 79: Effect of Prediction Horizon Length on Real-Time Model Predictive Control Performance

Presenter: Mark Morkos
Major: Engineering Technology
Department: Engineering Technology
Faculty Mentor: Junlin Ou

Abstract:

This project presents a systematic investigation of Model Predictive Control (MPC) performance for an omni-directional mobile robot operating in dynamic environments. The study focuses on evaluating the effect of prediction horizon length on trajectory tracking accuracy, computational load, and real-time feasibility. A Mecanum-wheel robotic platform is modeled and implemented using embedded hardware to enable closed-loop experimental validation. By varying the prediction horizon while maintaining consistent cost functions and constraints, the trade-off between control optimality and solver execution time is quantified. Performance metrics include root-mean-square (RMS) tracking error, control effort, and computation time per iteration. The results of this research aim to establish practical guidelines for selecting prediction horizon lengths that balance tracking precision with embedded computational constraints. This work contributes to improving the robustness and efficiency of real-time control strategies for autonomous mobile robotic systems.

Poster 80: Multimodal Dialogue Emotion Recognition with Temporal Modeling

Presenter: Cayden Schalk
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Dr. Jaishree Ranganathan

Abstract:

Emotion classification in dialogue and conversation remains a challenging problem because human emotion is communicated through multiple channels, including spoken language, vocal tone, facial expression, and the timing of conversational turns. Many existing approaches rely on only one modality or limited context, even though real conversations are both multimodal and temporally dynamic. This research investigates a multimodal framework for emotion classification in dialogues by integrating textual, acoustic, visual, and temporal representations.

Text features capture linguistic meaning, audio features reflect tone, visual features provide facial and expressive cues, and temporal modeling captures how emotions evolve across turns in a conversation. By combining these sources of information, this project aims to improve emotion recognition in multi-speaker dialogues beyond what unimodal approaches can achieve.

This study evaluates multimodal learning strategies on dialogue-based emotion datasets and examines the contribution of each modality to classification performance. The broader goal of this work is to support the development of more context-aware and socially intelligent AI systems, with potential applications in conversational agents, education, human-computer interaction, and mental health support technologies.

Poster 81: The Ethical Application of Artificial Intelligence in Chemistry Education

Presenter: Sydney Myers
Major: Chemistry
Department: Chemistry
Faculty Mentor: Dr. Amy Phelps

Abstract:

As the popularity and applications of artificial intelligence (AI) increase at a rapid rate, the concerns regarding its use also increase. In academic settings, some professors are embracing AI technology to aid in teaching, some are trying their best to avoid it completely and keep it away from students, and some have begrudgingly accepted the fact that AI is not going anywhere and they must learn to deal with it. While chemistry education researchers have begun to share individual opinions regarding the ethicality of AI use in chemistry education, there is no way of knowing if these are largely shared views of ethics or if there is any disconnect between parties in chemistry education. It would be beneficial to have a more widespread idea of the ethical frameworks undergraduate students, graduate students, and professors in chemistry are using to assess AI and what conclusions they are drawing. This study intends to survey students and professors in the chemistry department at MTSU. The survey will consist of situational questions involving ethical issues or dilemmas related to the use of AI in chemistry education. Participants will react to these situations using a Likert scale. Then, participants will be selected for in-person interviews, where the interviewer will investigate how and why participants are selecting their answers. The results of this study will indicate if individuals in chemistry education are more or less on the same page, or if professors need to initiate conversations with students about their expectations.

Poster 82: Comparing Elo Ratings, Classical Machine Learning, and Deep Neural Networks for Professional Tennis Match Prediction

Presenter: Lilly-Sophie Schmidt
Major: Computer Science
Department: Computer Science
Faculty Mentor: Khem Poudel

Abstract:

Professional tennis match prediction has remained stubbornly difficult despite decades of research, with accuracy plateauing around 70% using traditional methods. This thesis presents the first comprehensive comparison of modern predictive approaches under unified experimental conditions to determine whether recent advances in machine learning can break this barrier.

Four distinct methodologies were systematically evaluated on 133,138 professional men's tennis matches from 1968 to 2024: an Elo rating system baseline, ten classical machine learning algorithms, seventeen deep neural network configurations, and a novel hybrid approach combining Elo features with machine learning. All methods were tested on identical data using temporal train-test splits to ensure fair comparison.

The hybrid ELO-ML approach achieved the highest accuracy at 67.52% using AdaBoost, significantly outperforming pure machine learning (66.30%), deep neural networks (66.22%), and the Elo baseline (65.87%). This validates the effectiveness of integrating domain-informed features with algorithmic pattern recognition, demonstrating that expert knowledge encoded in features can substantially boost performance.

Surprisingly, classical machine learning and deep learning performed equivalently for this structured prediction task ($p=0.31$), challenging assumptions about deep learning superiority. However, neural networks exhibited superior probability calibration (ECE=0.0077 vs 0.0142), making them preferable for applications requiring reliable confidence estimates.

A critical finding emerged from systematic architecture exploration: deep learning model size had no impact on performance. Models with 207,000 parameters matched those with 21 million parameters, suggesting task complexity is limited by data quantity rather than model capacity. This enables deployment of tiny models on resource-constrained devices without sacrificing accuracy.

Despite methodological advances, the 70% accuracy threshold remains elusive, likely due to inherent human unpredictability and information constraints in pre-match scenarios. Future improvements will require richer data sources rather than purely algorithmic innovation. This research provides actionable deployment guidance for practitioners and establishes benchmarks for future sports analytics research.

Poster 83: Enhancing Resilience and Safety in Multi-Agent Systems (MAS) through Decentralized Failure Recovery

Presenter: Dimitri Nanmejo
Major: Computer Science
Department: Computer Science
Faculty Mentor: Dr. Joshua Phillips

Abstract:

In today's increasingly complex and demanding world, intelligent systems are essential for helping humans manage cognitive, operational, and decision-making challenges. Advances in artificial intelligence—particularly Large Language Models (LLMs)—have demonstrated remarkable capabilities in learning, reasoning, and assisting across diverse domains. However, many real-world problems require not just individual intelligent agents, but coordinated groups of agents working collaboratively. This shift toward Multi-Agent Systems (MAS) introduces new challenges, especially in maintaining reliability when individual agents fail or become unavailable.

This project investigates the resilience and safety of decentralized multi-agent systems under conditions of environmental stress and agent outages. Using the Mesa simulation framework, a Python-based platform for agent-based modeling and real-time visualization, we design and evaluate a two-phase recovery protocol for fault tolerance. The first phase implements a heartbeat detection mechanism that enables continuous peer monitoring and rapid failure identification. The second phase introduces a consensus-based task redistribution strategy that allows remaining agents to autonomously reassign responsibilities without reliance on centralized control.

We anticipate that the proposed decentralized recovery protocol will enable multi-agent systems to sustain coordinated operation following individual node failures, with neighboring agents adaptively assuming orphaned tasks based on proximity and capacity. The system is expected to maintain functional stability without centralized intervention, demonstrating that consensus-driven task redistribution prevents cascading failure and supports resilient large-scale autonomous coordination.

Poster 84: Machine Learning for CFD-Based Fluid Flow Simulation: A Comparative Study of Data-Driven, Physics-Informed, and Operator-Based Models

Presenter: Dipesh Shrestha
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Dr. Arpan sainju

Abstract:

Computational fluid dynamics (CFD) models based on the Navier–Stokes or shallow water equations (SWE) can accurately predict free-surface flows. However, they are often too slow for real-time forecasting, large parametric studies, or uncertainty analysis. This project studies machine learning (ML) surrogates to speed up SWE simulations while keeping acceptable accuracy. It compares three approaches: data-driven models (multilayer perceptron, CNN, and U-Net), physics-informed neural networks (PINNs), and operator-based models such as the Fourier Neural Operator (FNO). A two-dimensional SWE test case is used to create a shared dataset of water depth and depth-averaged velocity. All models are trained and tested under the same conditions. Performance is measured by prediction error, computational speedup, and robustness to changes in boundary conditions and geometry. It is anticipated that data-driven models such as CNNs and U-Nets will provide the fastest predictions on fixed grids, PINNs will improve physical consistency but may require longer training times, and FNO will offer better generalization across varying inputs and parameter settings. The goal is to enable faster and more reliable flood and free-surface flow modeling for scenario analysis and real-time decision-making.

Poster 85: Inside a Chemistry Department: Cultural Conditions Shaping Faculty Engagement in Teaching Reforms

Presenter: Abigail Nkuah
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Dr. Sarah Bleier-Baxter
Co-Presenters: Wang, C.,Davis, L., Temilade, T.,

Abstract:

The growing disconnect between higher education outcomes and undergraduate preparation has raised concerns for evidence-based teaching reform (NSF, 2020). Faculty motivation has been found to play a vital role in these efforts (Stupnisky et al., 2018). According to self-determination theory, faculty motivation can be shaped by the satisfaction of their psychological needs for competence, autonomy, and relatedness and can influence their involvement in reform efforts (CAR; SDT; Deci et al., 2017; Ryan & Deci, 2022).
Even though SDT has been used to explore student motivation in different aspects of the chemistry discipline (Black & Deci, 2000) and faculty experiences in STEM fields (Crick et al., 2019; Seipel & Larson, 2016), there is very little research examining how chemistry departmental culture specifically shapes faculty perceptions competence, autonomy, and relatedness. We use the four frames model (Reinholz & Apkarian, 2018) to examine chemistry faculty experience of their departmental culture. The four frames and SDT help to understand the role departmental culture plays in influencing faculty perception of competence, autonomy, and relatedness to foster an inclusive, collaborative, and supportive culture aimed at sustained pedagogical advancement.
We addressed the following research question: How do chemistry faculty's experience of departmental culture (through Four Frames) relate to their perceptions of psychological needs (through SDT) and their motivation to engage in teaching reforms?
We provide emerging themes from a focus group interview that shows how the departmental teaching culture connected to faculty's psychological needs, influencing their engagement with teaching reforms. The findings include pedagogical uncertainty, tenure-based power dynamics, collaborative teaching culture, complacency as barriers and supports to influencing how faculty engage with innovative teaching reforms. This shows that chemistry faculty's perception of their psychological needs is related to departmental culture across the four frames.

Poster 86: Design and Biochemical Evaluation of Novel Pyrazolo-Quinolin-5-One Derivatives as Potent Autotaxin Inhibitors to Overcome Chemotherapy Resistance

Presenter: Isaac Smith
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Souvik Banerjee

Abstract:

Abstract: Therapeutic resistance in metastatic cancers remains a major barrier to successful treatment. The autotaxin–lysophosphatidic acid (ATX–LPA) signaling axis plays a critical role in tumor progression, metastasis, and the development of chemoresistance, making Autotaxin (ATX) an attractive target for therapeutic intervention. ATX catalyzes the production of LPA, a bioactive lipid that activates pro-survival and pro-migratory signaling pathways frequently exploited by tumors during chemotherapy. Previous preclinical studies from the Banerjee Research Group identified validated ATX inhibitors, including ATX-1d and MolPort-137, which enhanced paclitaxel potency and re-sensitized paclitaxel-resistant cancer cell lines, demonstrating the therapeutic promise of targeting this pathway. Building on this foundation, the present study investigates a novel series of pyrazolo-quinolin-5-one derivatives designed and synthesized to function as potent ATX inhibitors. A focused library of derivatives was prepared and comprehensively characterized using nuclear magnetic resonance (NMR) spectroscopy, mass spectrometry, and chromatographic techniques to confirm structural integrity and purity. The inhibitory activity of these compounds was quantitatively evaluated using a fluorescence-based ATX enzyme inhibition assay, enabling the establishment of structure–activity relationships (SAR) and identification of chemical features critical for potency. Six derivatives demonstrated unique and reproducible ATX inhibitory activity in the nanomolar range, representing highly potent candidates for further development. These promising compounds will be advanced to cell-based studies to evaluate their biological relevance, including assessment of cytotoxic effects as single agents and in combination with paclitaxel in paclitaxel-resistant cancer cell models. By integrating synthetic chemistry, biochemical validation, and cellular evaluation, this research highlights the pyrazolo-quinolin-5-one scaffold as a powerful platform for ATX inhibition. The findings support continued hit-to-lead optimization and underscore the potential of targeting the ATX–LPA axis to overcome chemotherapy resistance and improve therapeutic outcomes in aggressive metastatic cancers.

Poster 87: Design of an aurone-based fluorescent probe conjugated with a nitrobenzofurazan or 2,4-dinitrobenzenesulfonate moiety for the selective detection of glutathione

Presenter: Amos Olatunbosun
Major: Chemistry
Department: Chemistry
Faculty Mentor: Dr Scott Handy

Abstract:

Glutathione (GSH), the most abundant intracellular biothiol, plays crucial roles in maintaining physiological homeostasis. Marked fluctuations in its levels have been associated with cancers, cardiovascular disorders, neurological diseases, inflammations and organ damage. Fluorescence-based probes provide high sensitivity and specificity for monitoring biomolecules. However, current fluorescence technologies for GSH characterization built on chemical groups such as coumarin, 1,8-naphthalimide, cyanine, xanthene, BODIPY, benzothiazole and rhodamine scaffolds remain limited by poor selectivity and narrow emission range. Our approach is to propose the design of a novel aurone-based probe conjugated with a nitrobenzofurazan or 2,4-dinitrobenzenesulfonate moiety for the selective detection of GSH. The aurone core offers favorable and tunable photophysical properties. This dual design is expected to enhance selectivity for GSH and tune emission wavelengths, thereby contributing to addressing key challenges with present GSH sensing. The development of such an organic small-molecule fluorescent probe has the potential to advance disease diagnosis and biological imaging through more accurate detection of GSH dynamics.

Poster 88: The impact of the 2012 Drought on Corn Yield Irrigated vs. Non-Irrigated

Presenter: Sydnee Sommers
Major: Animal Science
Department: Agriculture
Faculty Mentor: Justin Gardner
Co-Presenters: Cristine Bartolini, Eli Dunn, Kaylyn Huber, Lucas Sutherland

Abstract:

In 2012 the continental United States experienced a widespread drought. The Palmer Drought Severity Index showed severe drought conditions in virtually all of the Midwest and Southeast throughout the summer of 2012. Fortunately, 2012 coincided with the census of agriculture, which is conducted every five years. Thus, the public has access to county-level data on crop production practices, including irrigation.
Our objective is to test multiple hypotheses on the effectiveness of irrigation under drought and non-drought conditions by comparing 2012 to 2017 (a non-drought year). As well as the correlation between yield and the Palmer Drought Severity Index on both irrigated and non-irrigated yield in both a drought year and a non-drought year.
We expect yield to drop as drought severity increases, while irrigation reverses this trend. But the key question is how much. If irrigation has a negligible impact on yield, then irrigation may not be cost-effective. On the surface, this seems like a simple project with an obvious answer; preliminary results show that irrigation improves yields. However, the data are prone to selection bias. Farmers in drought-prone areas are more likely to invest in expensive irrigation infrastructure. Therefore, we will use a fixed effects model and/or an instrumental variable method to correct for endogeneity.

Poster 89: Evaluating Non-Stationarity Handling Strategies for Short-Horizon Equity Return Forecasting

Presenter: Megh Patel
Major: Computer Science
Department: Computer Science
Faculty Mentor: Dr Philips

Abstract:

Forecasting short-horizon equity returns is a challenging problem in financial machine learning due to low signal-to-noise ratios and persistent non-stationarity in financial markets. Predictive relationships between market variables and asset returns evolve over time as a result of economic cycles, volatility changes, and structural market shifts, often causing predictive models to degrade in performance. While deep learning architectures such as long short-term memory (LSTM) networks and transformer-based models have shown promise in time-series forecasting, their robustness under changing market conditions remains unclear.

This study evaluates multiple strategies for handling non-stationarity in equity return forecasting within a unified experimental framework. Specifically, it compares (1) static deep learning models, (2) regime-aware approaches using Hidden Markov Models to capture latent market states, and (3) drift-aware adaptive models that employ concept drift detection to trigger retraining. A hybrid approach combining regime detection and adaptive updating is also investigated.

All models are evaluated using a strict point-in-time rolling-window validation framework to prevent look-ahead bias. Using daily CRSP data for S&P 500 equities from 2000–2024, performance is assessed through predictive accuracy, directional accuracy, Sharpe ratio, and stability over time. The study aims to identify which strategy most effectively improves forecasting robustness in dynamic financial environments.

Poster 90: Do Set Transformers Have Attention Sinks? High-Norm Token Analysis and Mitigation

Presenter: Nada Srour
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Joshua Phillips

Abstract:

High-norm “artifact” tokens have been identified in Vision Transformers, where a small subset of tokens attains unusually large embedding norms, dominates attention, and often aligns with low-informative background regions. Closely related “attention sink” behavior has also been reported in autoregressive language models.
Despite this progress, the presence and impact of sink-like tokens have not been systematically studied in set-based Transformers for permutation-invariant inputs, such as SetBERT, a state-of-the-art Set Transformer style model for high-throughput sequencing microbiome data.
To bridge this gap, we propose the first targeted analysis of high-norm tokens in SetBERT. We will (i) define and quantify token-norm outliers across layers and heads for sequence/taxa tokens, (ii) test whether outliers correspond to low-information or high-frequency taxa patterns, and (iii) evaluate mitigation strategies inspired by register tokens, including auxiliary learnable “register” elements that may absorb global computation and redistribute attention away from biological entities. We hypothesize that detecting and controlling these tokens will improve attention-based interpretability and yield more stable, biologically meaningful taxa attributions without degrading predictive performance.

Poster 91: LLM Proposes, Coq Disposes: Quantitative Tactic Evaluation for Neural Theorem Proving in Rocq

Presenter: Om Patel
Major: Mathematics
Department: Computer Science
Faculty Mentor: Dr. Devin Jean

Abstract:

Neural theorem proving has seen significant advances in recent years, yet the majority of progress targets the Lean proof assistant, leaving the Rocq (formerly Coq) ecosystem underserved. Rocq's stricter type system and more rigid tactic language expose the limitations of LLM-based tactic generation, as a substantial portion of model-generated candidates fail kernel validation. Existing approaches address this unreliability through expensive backtracking search on GPU clusters.

We present Rocq-QLG (Quantitative Lemma-Graph Prover), a neural theorem proving system built on a key insight: separating tactic generation from tactic evaluation. Rather than trusting the language model's judgment, Rocq-QLG treats the LLM as a candidate proposer and evaluates each suggestion through a three-stage pipeline. First, the LLM generates multiple candidate tactics per proof step. Second, a sandbox filter executes every candidate in a real Coq kernel session using a checkpoint-test-rollback protocol, eliminating invalid tactics and recording failures as negative constraints for future attempts. Third, a quantitative scorer ranks surviving candidates across six independent signals, including subgoal reduction, hypothesis utilization, and term simplification, combined via a weighted sum with a three-tier hierarchy that deliberately deprioritizes LLM confidence. The highest-scoring tactic is committed irreversibly in a greedy, single-pass architecture with no backtracking.

On a benchmark of 118 Coq standard library theorems spanning four categories and difficulty levels, Rocq-QLG achieves an 86 to 89% prove rate across three independent clean-slate evaluations with zero false positives, running entirely on consumer hardware without requiring local GPU resources or cluster-based backtracking search. The quantitative scorer overrides the LLM's preferred tactic in 25% of proof steps, demonstrating that in Rocq's strict environment, how you evaluate tactics matters more than how you generate them.

Poster 92: Effects of UV Radiation on the Alternative Splicing of the MCA2 Exon 8 gene

Presenter: Madelyn Sullivan
Major: Biology
Department: Biology
Faculty Mentor: Michael Swanepoel

Abstract:

The purpose of this experiment was to observe the pattern of the MCA-2 gene exon 8 in Caenorhabditis elegans under UV stress. RT- PCR and agarose gel electrophoresis techniques were used to observe skipping or inclusion of exon 8 in the RNA of C. elegans. RT-PCR was successful at all three temperatures. The annealing temperature of 53.3 degrees Celsius was chosen because it displayed the brightest bands, and all three temperatures had the same fragment sizes. Alternative splicing was not observed in the samples, Control and experimental. The isoform1 was 100% the same as the reference sequence in both coverage (cov) and percent identity (pid). The unspliced had a cov of 83.9% and a pid of 99.2% meaning most of what was present matched the REFSEQ. The unspliced is missing the pfam12424 domain. All of the other domains are present in REFSEQ, Isoform1, and Unspliced (PRK10517, pfam00689, pfam00122, and smart00831). Based on the present domains in Isoform1, it is functional like the reference sequence. The unspliced is missing a domain, but is likely functional compared to the reference sequence. Functional protein domain (REFSEQ) is present under treated and untreated conditions. REFSEQ, Isoform 1, and Unspliced were not present in the control or experimental PCR. UV stress does not have an effect on the lifespan of C. elegans with the MCA-2 gene exon 8.

Poster 93: SPA: Subspace Projection Aggregation for Privacy-Preserving Heterogeneous Federated Fine-Tuning of Large Language Model

Presenter: Samir Poudel
Major: Computational and Data Science
Department: Computer Science
Faculty Mentor: Dr Kritagya Upadhyay

Abstract:

Federated Learning (FL) enables privacy-preserving training of Large Language Models (LLMs) but struggles with system heterogeneity, particularly when clients possess varying computational capabilities. Standard aggregation methods require uniform model architectures, forcing a ``lowest common denominator'' approach that throttles high-end devices. We propose Subspace Projection Aggregation (SPA), a novel framework that addresses this by treating client updates as overlapping subspaces. Using Singular Value Decomposition (SVD), SPA projects high-rank updates from capable clients into optimal lower-rank approximations for resource-constrained peers. Experiments on the Yelp Review dataset using Qwen2.5-7B show that SPA achieves 63.8% accuracy, outperforming homogeneous baselines by 2.6% while reducing communication costs by 25%. Our approach effectively distills knowledge from heterogeneous sources, proving that device diversity can be an asset rather than a liability in federated LLM fine-tuning.

Poster 94: Quantitative comparison of manual and AI-based segmentations of digital bone models using the 3D Slicer™ extension Total Segmentator

Presenter: Zaynab Syed
Major: Biochemistry
Department: Biology
Faculty Mentor: Megan Moore
Co-Presenters: Arshia Malhotra, Adriel Nuta ,Sofia Barreda, Jon Hubbell

Abstract:

The accuracy of automated segmentations of 3D bone models using the 3D Slicer™ extension Total Segmentator is unknown. To compare the accuracy of the segmentations, bone models were derived from existing CT scans from the New Mexico Decedent Image Database. Manual segmentations were performed by undergraduate researchers using the Segment Editor in the 3D Slicer™ program. Automated segmentations were done using the extension Total Segmentator™ fast mode. Both methods were applied to create bone models of the humerus, lumbar vertebrae, and pelvis. Model measurements were performed with a minimum of three measurements taken on each model following standard osteometric measurements of the humerus and vertebrae and obstetric measurements of the articulated pelvis.

Of the 90 total measurements compared using the intraclass correlation coefficient (ICC) in SPSS™ 31.0, the average measures ICC is highest for the humerus (0.973) and pelvis (0.908) and lowest for the lumbar vertebrae (0.595), with the overall ICC average measures at 0.840 ($p<.001$ for all analyses). This variability in accuracy is likely a reflection of the low bone density and high rate of pathology in the vertebrae relative to the humerus and pelvis.

Based on the manual and automated measurements, we can reject the null hypothesis that there is no reliability between the manual and the automated segmentations for the humerus and pelvis, but not for the vertebrae. This justifies the use of automated segmentation, which is a more time efficient and consistent measurement method. Osteological expertise may also play a role, but was outside the scope of this study. The benefits of AI outweigh the detriments of producing manual segmentation for the long bones and pelvis, as there is a less steep learning curve, less time investment, and the models are useful for biomedical and forensic science applications.

Poster 95: Balancing Safety and Efficiency through Airport Operations and Project Management at Boise Airport

Presenter: Maheswari Ramesh
Major: Aerospace
Department: Aerospace
Faculty Mentor: Dr. Chaminda Prelis

Abstract:

This research uses Boise Airport (KBOI) as the primary case study to examine the organizational paradox of balancing operational efficiency with non-negotiable safety standards during the 2025-2029 construction cycle, where the airport is expected to undertake multimillion-dollar projects, including the construction of new Concourse A and runway reconstructions. The study analyzes several case studies and identifies silos (departmental disconnects) between different departments, as well as tenant gaps with airport tenants, which create latent conditions that threaten airfield integrity. Furthermore, quantitative data from the Aviation System Performance Metric (ASPM) databases indicate that during construction-related closures, a complexity tax, namely that hidden costs, extra time, and increased risk that occur when the organization tries several high complexity projects at once, results in increased average taxi-out times compared to non-construction years. Therefore, to resolve those issues, this thesis proposes an integrated operational roadmap that mainly focuses on the Prescriptive Decision Support System (PDSS). Key solutions include a Key Performance Indicator (KPI) driven dashboard that features a four-party digital handshake model, utilizing the M/M/s queuing theory to optimize aircraft routing, and the hybridization of the Safety Management System (SMS) with Business Continuity Planning (BCP). Ultimately, this research provides a scalable blueprint for Boise Airport and other similar airports to ensure that any physical modernization now and in the future does not compromise operational safety.

Poster 96: Charge transfer complexes of tetrameric Cu-based "tweezer" molecules

Presenter: Avery Thomas
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Andrienne Friedli
Co-Presenters: Cynthia Alonzo Rosales, Oleksandr Hietsoi

Abstract:

Charge transfer (CT) complexes are composed of donor and acceptor molecules that exchange at least one electron from donor to acceptor. One characteristic of CT compounds is that they have a CT band in the UV that makes them sensitive to their environment and potentially applied as sensors. Our group discovered a Cu-based tweezer molecule with two pincers terminated in a pyridyl group (donor). The tweezers can also hypothetically be formed with terminal pyridiniums through complexation of mono alkyl pyridiniums with Cu(II). The purpose of the project reported here is to investigate the Cu-based donor and acceptor molecular tweezers as CT complexes. The donor form was synthesized by combining Cu(pdc)(H2O)3 (1) and 1,4-di(4-pyridyl)benzene (DBP) in H2O at 120 oC for 24 h, which resulted in large blue crystals of tetrameric materials (TT) upon slow cooling. Compound TT has a UV □max at 278 nm and fluoresces at 341 nm in DMSO. In attempting to make acceptor tweezers, two methods were used. In the first approach, 1 eq of alkyl halide (MeI) was added to the TT in DMSO at a time, and reaction followed with UV and fluorescence spectroscopy. Since methyl iodide appeared to form a yellow biproduct independent of TT, a second method focused on making the acceptor tweezer using the N-propyl derivative of DBP (PrDBP) and 1 under the same conditions used to synthesize TT. The PrDBP was synthesized by heating DBP and bromoethane in MeCN at 65 oC for 48 h and the structure was confirmed by 1H NMR. Donor tweezers are expected to react with common acceptors: TCNQ, DDQ, and viologens to form CT complexes. Acceptor tweezers are expected form CT complexes with typical donors (R)-binaphthol, p-dimethoxy and m-dimethoxybenzene. Results of these potential reactions will be discussed in the poster.

Poster 97: Atomic Absorption Spectroscopic Characterization of Bullet Alloy Ratios: Implications for Firearm Identification from Gunshot Residue on Bone and Other Impact Surfaces

Presenter: Ava Ruzzo
Major: Forensic Science
Department: Chemistry
Faculty Mentor: Jan Halamek

Abstract:

Ballistic evidence is central to thousands of criminal investigations each year. As firearm-related violent crime rises, the demand for scientifically rigorous, objective, and rapid projectile analysis has intensified. Traditional firearm and toolmark examinations, as practiced under guidelines from the Association of Firearm and Tool Mark Examiners, have faced scrutiny due to concerns about subjectivity and limited statistical validation under judicial evidentiary standards. Currently, no validated method allows identification of a bullet manufacturer without recovering the projectile or firearm. This project evaluates the application of Atomic Absorption Spectroscopy (AAS) for elemental profiling of ammunition. AAS enables quantitative detection of metallic constituents—i.e., lead, antimony, copper, etc.—present in bullet cores and jackets. Preliminary data indicate that inter-element concentration ratios may provide manufacturer- and type-specific signatures. Metallic residues transferred to surfaces upon impact can be chemically extracted and analyzed, enabling potential source attribution when bullets or firearms are not recovered. These surfaces include the bones and soft tissues of victims in firearms deaths. Bullet material research helps forensic anthropologists better understand skeletal trauma caused by firearms. Different bullet types and compositions interact with bone in distinct ways, producing recognizable patterns to reconstruct shooting events. Lead bullets often leave gray staining around entry wounds due to metal transfer. Copper-jacketed bullets may produce greenish discoloration from oxidation. Steel-core ammunition typically penetrates deeper and creates more extensive fracture patterns due to hardness. Frangible bullets break apart on impact, resulting in multiple small bone and bullet fragments. Material properties also influence energy transfer to bone. Softer bullets can deform and expand, increasing fracture spread, while harder projectiles maintain shape and produce narrower wound channels. These material-specific characteristics assist investigators in determining trajectory, number of impacts, angle of impact, and possible ammunition type. Overall, studying bullet materials strengthens scientific interpretation of firearm-related skeletal injuries in forensic casework.

Poster 98: Poisoned Pages: Testing for Toxic Elements in 19th Century Book Bindings

Presenter: Laurel Thompson
Major: Biology
Department: Chemistry
Faculty Mentor: Sarah Pierce, Jesse Weatherly, Susan Martin, Susan Hanson
Co-Presenters: Brittney Cupp, Olivia Sanders

Abstract:

Book binding in the 19th century used a number of pigments that contained toxic elements. Inspired by the Poison Book Project, started by the University of Delaware, our project aimed to identify potential toxic elements of 19th century books housed in MTSU's Walker Library Special Collections. To identify the toxic elements, we used X-ray fluorescent (XRF) spectroscopy. This technique was used because it is non-destructive and would not harm any historical books. Analysis of chemical composition by XRF is done by using an X-ray source to excite the atoms and measuring the energy of the emitted photon produced when the atom relaxes to a ground state. Elements can be identified on the book covers because each element has a unique fingerprint. Of the 34 books examined in fall 2025, 33 (97.1%) contained toxic elements, including heavy metals such as lead (Pb), arsenic (As), mercury (Hg), copper (Cu), iron (Fe), and chromium (Cr). In this poster, additional data from spring 2026 will also be presented.

Poster 99: Germination behavior of Elaeagnus multiflora in response to seed freshness, stratification duration, and GA3

Presenter: Kathryn Serrano
Major: Biology
Department: Agriculture
Faculty Mentor: Nathan Phillips

Abstract:

Elaeagnus multiflora is a shrub from east Asia that has multiple valuable properties including nitrogen fixing, edible berries, and ornamental application. Its recent rise in popularity demands efficient propagation methods, but the current ideal method, stem cutting, produces low amounts of successful plants. By studying the effects of cold stratification, warm stratification, and GA3 on both fresh and dry seeds, an alternative, more efficient germination method may be developed.

Poster 100: Online Education to Support Youth Judging Scores

Presenter: Caroline Tywater
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

Horse judging contests are an increasingly popular event within the equine industry as they have proved to develop industry knowledge and confidence, as well as important soft skills such as leadership, communication, and decision-making. Many associations have recognized the need and desire for online education and have begun creating resource libraries for their members to utilize. The objective of this study is to evaluate the effectiveness of supplemental online instruction and to assess how this can improve youth judging scores. Recognizing that online platforms for learning can be vital for youth equestrian development, this project has partnered with IEA (Interscholastic Equestrian Association) to create an online judging contest. Aiming to create an extensive online resource library, IEA has begun building educational content for any member to utilize in hopes to elevate young equestrians' understanding of important industry knowledge and concepts. The online judging contest consists of four classes; Halter, Horsemanship, Ranch Riding, and Reining. The first set of online content is aimed towards introductory level youth judges, and each class includes a demonstration which is scored and explained by expert judges. This content is available to all IEA members to study, practice, and prepare. Youth IEA members who participate in APHA's (American Paint Horse Association) Horse IQ Judging Contest in 2025 and 2026 will have their scores evaluated and identification of score differences between participants who did or did not complete the online content will be recorded. Youth who completed the online contest may be better prepared to compete at a live judging contest. It is expected score averages may increase and notable improvement may be measured for classes in which supplemental online content was available to study.

Poster 101: Supporting Cross-Cultural Mentorship Among Graduate Students Through an Asset-Mapping Tool

Presenter: Saya Shahoy
Major: Mathematics and Science Education
Department: Biology
Faculty Mentor: Angela Google

Abstract:

Science graduate students from underrepresented racial groups (URGs) often experience negative academic and training environments. Although science graduate programs aim to foster diverse and inclusive spaces, students are not always supported in recognizing and leveraging their culturally rooted assets. Helping students identify those assets is therefore critical to promoting their persistence and success.

Mentorship is central to student success, particularly for URG students. Given that many URG students lack access to mentors who share their social identities, they often engage in cross-cultural mentorship relationships, which can shape their experiences in academic spaces. This study explores students' perceptions of academic culture within positive cross-cultural mentorship relationships using an asset-mapping activity.

Three research questions guided our study. (RQ1) What cultural capital do science graduate students recognize and leverage as they navigate their programs? (RQ2) What assets are developed in response to navigating their programs? (RQ3) How do their experiences shape their professional science identity? We conducted eight focus groups (N = 27) across six R1 institutions during Fall 2024. Participants completed an asset-mapping activity where they identified strengths and contributions to their research labs and programs.

Guided by frameworks of community cultural wealth and science identity, we analyzed how students experience their research labs, programs, and the broader field of science. Findings indicate students draw on diverse forms of capital and cultural assets to persist and thrive in graduate education. (RQ1) Students navigate academic systems by employing adaptive strategies while reimagining and prioritizing power skills. (RQ2) As students navigated unique cultural and institutional challenges, they leveraged and developed resistant capital through cultural resilience, and resistance to traditional science norms. (RQ3) Consistent self-reflection was critical to students' science identity development. This work informs efforts to foster more inclusive academic environments while equipping students with a tool to navigate graduate education successfully.

Poster 102: Asymmetric Matrix Analysis of STEM Departmental Social Network Structure

Presenter: Cory Wang
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Dr. Sarah Bleiler-Baxter
Co-Presenters: Cassandra Mohr, Andrew Puente

Abstract:

In order to address the growing demand for STEM graduates in the twenty-first century, discipline-based education research has repeatedly called for the adaptation of innovative teaching practices in undergraduate STEM departments. Evidence has shown that embracement of teaching innovations tends to be isolated within small subsets of individuals. This motivates the need to study the diffusion of teaching innovations from individuals and subsets of individuals to the larger culture of departments. The Advancing the Culture of Teaching in STEM (ACT-STEM) research team posits the social structure and dynamics of departments are key factors which support or thwart the diffusion of teaching innovations. In this project, we use social network analysis (SNA) to characterize the structure of social dynamics of STEM faculty who participated in a year-long teaching professional development (TPD) program. We administered a survey to participants of the TPD program which asked for the frequency of each participants' interactions with other participants in the program. A social network was constructed using survey responses. Analysis of the social network adjacency matrix revealed participants' reports were systematically inconsistent with one another, resulting in a highly asymmetric adjacency matrix. Such asymmetry is typically undesirable in SNA. In alignment with Jain et al. (2017), Li et al. (2016), and Su et al. (2021), however, we posit adjacency matrix asymmetry uncovers informal associations, power relations, and the nature of relationships within a social network. These aspects are critical to the diffusion of innovations but would be treated as noise if asymmetry were ignored. In this poster, we will conduct asymmetric matrix analysis using spectral methods to shed light on the nature of the TPD social network. We will also discuss the ramifications of the asymmetric matrix analysis on the potential for teaching innovation diffusion across the TPD social network.

Poster 103: Modeling Obesity-Driven Stroke Risk for LTC Insurance Valuation

Presenter: Kaijie Shi
Major: Actuarial Science
Department: Mathematics
Faculty Mentor: Vajira Manathunga

Abstract:

Obesity has emerged as a dominant modifiable risk factor for stroke, yet its actuarial implications for life and long-term care (LTC) insurance pricing remain insufficiently quantified. This study develops a continuous-time Markov multi-state model to estimate obesity-attributable stroke transition intensities and their downstream effects on insurance product valuation. Using nationally representative survey data linked to mortality records, we construct stratum-specific transition intensities across age, sex, and BMI categories for three critical pathways: healthy-to-stroke, healthy-to-death, and post-stroke-to-death.

Our modeling framework addresses several methodological challenges inherent in survey-to-insurance calibration, including sparse stroke-death events, cohort-entry structures, and BMI measurement error. The competing risks formulation explicitly accounts for the reality that individuals may die before experiencing a stroke, with BMI-specific hazard ratios scaling baseline mortality derived from standard life tables. This framework provides insurers with tools to price obesity-related risk more accurately, assess reserve adequacy under changing population health dynamics, and evaluate the economic value of preventive health interventions. Our findings have implications for product design, underwriting practices, and public health policy coordination with private insurance markets.

Poster 104: The Tornado of Mathematical Knowledge: Revealing the Structure of Mathematics Through Contemporary Applied Mathematics

Presenter: Cory Wang
Major: Mathematics and Science Education
Department: Mathematics
Faculty Mentor: Dr. Sarah Bleiler-Baxter

Abstract:

Mathematical structure refers to the characteristics, topology, dynamics, and relationships within and between mathematical concepts invariant to the contexts and interpretations which instantiate the concepts. According to the structuralist philosophy of mathematics, structure is the fundamental building block of mathematics, but the notion of mathematical structure also plays a key role in other realist philosophies of mathematics such as Platonism and Lakoff and Núñez's embodied cognition (2000). In this talk, I will propose and explicate an emergent theoretical framework, the Tornado Theory, which emerges from the structuralist, Platonist, and embodied cognitive views to characterize the nature of mathematical structure. In particular, the Tornado Theory proposes a duality between the Platonist and embodied cognitive approaches, which when mediated by mathematical structure, is "the driving force behind the incessant growth of [mathematical] knowledge" (Sfard, 2003, p. 359). The Tornado Theory could be used as a starting point to guide research characterizing the nature of mathematical structure. In this poster, I demonstrate the Tornado Theory, when synthesized with specific approaches from contemporary physics and engineering, namely network theory, information theory, and dynamical systems theory, could reveal key structural information about the discovery, creation, teaching, and learning of mathematics.

Poster 105: Impact of WDR5 and G9a Inhibition on MYCN-Driven Neuroblastoma

Presenter: Maheswari Vaghela
Major: Molecular Bioscience
Department: Biology
Faculty Mentor: Dr. April Weismmiler

Abstract:

Neuroblastoma (NB) is the most common extracranial solid tumor that occurs in children less than 5 years old. It is an embryonic tumor arising from precursor cells in the sympathetic nervous system and adrenal medulla and can also be present in the neck, chest, abdomen, or pelvis. About one in every 7,000 children is affected at some time. Amplification of the MYCN gene, encoding N-MYC, represents a key biological feature in approximately 50% of high-risk NB cases. Elevated N-MYC levels are strongly associated with poor prognosis of NB. MYCN promotes oncogenesis by activating the expression of ribosome biogenesis and protein synthesis genes and repressing neuronal differentiation genes. Therefore, impairing N-MYC is very crucial but since it has disordered structure it is difficult to design a direct drug inhibitor. And that's why the alternative approach left is to indirectly impair N-MYC function by targeting its cofactors. Our study focuses on targeting two N-MYC cofactors called WDR5 and G9a. WDR5 is a chromatin regulator which directly interacts and recruits MYC to chromatin at specific target genes involved in ribosomal subunits and protein synthesis. Using C16 we blocked the WIN site of WDR5 which prevented it from binding chromatin, thereby reducing MYCN-amplified NB cell proliferation. G9a is a histone methyltransferase that catalyzes H3K9 mono- and di-methylation and marks gene repression. G9a is overexpressed in many cancers and inhibiting G9a using the UNC0642 is expected to upregulate differentiation and development. Using these two drugs individually and in combination, we assessed transcriptional changes via RNA-seq and examined mRNA and protein levels of apoptotic marker genes, as well as differentiation and cell proliferation genes like GAP43, RPL5, H3K9me2, P53, MDM4 and P21. By understanding the roles of these two cofactors we may potentially overcome single drug resistance, reduce cancer relapses, and enhance the effectiveness of chemotherapies.

Poster 106: Investigation of Photo-Smiles Rearrangement in Formation of 9- and 10-Substituted Planar Blatter Radicals

Presenter: Erin Westerman
Major: Chemistry
Department: Chemistry
Faculty Mentor: Dr. Andrienne Friedli

Abstract:

Blatter radicals, specifically benzo[e][1,2,4]triazin-4-yl derivatives, are highly valued in polymer science, molecular electronics, and spintronics due to their exceptional stability, extensive spin delocalization, and low excitation energies. Current research focuses on tuning their electronic and magnetic properties through structural modifications. In some cases, formation of these derivatives from aryloxy ether precursors proceeds via an unexpected intramolecular rearrangement consistent with a photo-Smiles mechanism. This study examines the role of photo-Smiles rearrangement in the photochemical synthesis of planar Blatter radicals and identifies conditions and substituents that favor photocyclization. A series of precursor ethers was prepared from meta- and para-substituted phenols bearing methoxy (a), fluoro (b), dimethylamino (c), and trifluoromethyl (d) groups, along with an unsubstituted reference ether (e). These precursors were subjected to photochemical conversion to yield annulated Blatter radicals. The ethers and photoproducts were characterized by multinuclear NMR, UV-Vis spectroscopy, and ESI-MS. Additional electrochemical, EPR, and DFT computational studies will be completed via collaboration with the University of Łódź. The research seeks to confirm the involvement of photo-Smiles rearrangement, evaluate substituent effects on reactivity, and provide access to novel C9-substituted Blatter radicals for advanced magnetic and electronic materials.

To date, nine ethers (four meta-substituted, four para-substituted, and one reference ether) have been synthesized and fully characterized by multinuclear NMR and single-crystal X-ray diffraction (SC-XRD). Ethers bearing a, b, and c underwent efficient photocyclization, whereas d-substituted ethers underwent no reaction, and the ether with c at the para position exhibited unexpected resistance. Notably, the isomeric pair of c-substituted ethers displayed markedly divergent photochemical behavior, offering valuable insights into mechanism and substituent influence. Mechanistic studies, including comparative kinetic analysis of photocyclization rates via UV-Vis monitoring, are planned. Future efforts will focus on improved purification for elemental analysis, DFT-based mechanistic elucidation, and refined synthetic protocols to deepen understanding of photo-Smiles rearrangements in this system.

Poster 107: Diagnosing Ketosis in Early Lactation Dairy Cows

Presenter: Catalina Valdivia
Major: Animal Science
Department: Agriculture
Faculty Mentor: Dr. Caitlin Foley
Co-Presenters: Grayson Tidwell, Maria Pito, Sydney Sommers

Abstract:

Ketosis is one of the most challenging metabolic disorders affecting the dairy industry. While dairy cattle are one of the most researched animals in the world, debates still continue among scholars regarding the best management practices to diagnose and treat this disorder. The purpose of this study is to assess clinical and subclinical levels of ketosis in early lactation dairy cows and compare three diagnostic tests: Urine Ketone Strips, Milk Ketone Strips, and a Handheld Ketone meter. The tests will be compared by cost, efficiency, accuracy and ease of use. Cows housed at the MTSU Dairy Farm will be sampled weekly for the study duration. Additionally, body condition scores pre and post-calving, milk production data, and basic physical exam data will be collected for evaluation of total disease status. It is hoped that the study results will aid the MTSU Dairy Farm in evaluating their current diagnostic and treatment protocols and improve overall herd health.

Poster 108: Galactolipids of the Terrestrial Dinoflagellate Rufusiella insignis: Comparison to Aquatic Dinoflagellates

Presenter: Joshua Whitlock
Major: Biology
Department: Biology
Faculty Mentor: Dr. Jeff Leblond

Abstract:

Rufusiella insignis has a great range of terrestrial habitats worldwide, from soil in the Great Smoky Mountains to rocks in Japan. Aside from simple studies of its presence in various terrestrial sites, very little is known about it. However, It is considered very unusual as most dinoflagellates are aquatic. Notably, nothing is known about its fundamental biochemistry, such as lipid composition, and how it compares to better studied aquatic dinoflagellates. All eukaryotic photosynthetic life has photosynthetic membranes composed chiefly of the galactolipids mono- and digalactosyldiacylglycerol (MGDG and DGDG, respectively). Our lab has considerable experience in characterizing MGDG and DGDG of dinoflagellates, having discovered that peridinin-containing freshwater and marine dinoflagellates, the largest photosynthetic group, are divided into two clusters according to galactolipid composition: 1. a cluster with C20/C18 polyunsaturated fatty acids (sn-1/sn-2 regiochemistry) as the dominant forms of MGDG and DGDG, and 2. a cluster with C18/C18 polyunsaturated fatty acids as the dominant forms of MGDG and DGDG. As a dinoflagellate that is disconnected from aquatic environments, we sought to characterize the galactolipids of R. insignis isolated from a rock wall in Japan to determine if it is placed within one of these clusters or if has evolved a different set of fatty acids associated with MGDG and DGDG to allow it to survive in non-aquatic environments. We have determined using positive-ion electrospray/mass spectrometry (ESI/MS) that R. insignis produces four galactolipids, 20:5/18:5 MGDG, 20:5/18:4 MGDG, 20:5/18:4 DGDG, and 20:5/22:6 DGDG, to firmly place it within the C20/C18 cluster of aquatic dinoflagellates. However, of these galactolipids, 20:5/22:6 has rarely been observed in aquatic taxa and may be produced as an adaptation to an aerial environment by modifying the fluidity of chloroplast membranes.

Poster 109: Investigating Host-Guest Interactions Between Tetrameric Copper Tweezers and Aromatic Fluorophores

Presenter: Keira Warren
Major: Biology
Department: Biology
Faculty Mentor: Andrienne Friedli
Co-Presenters: Jackson Starr, Keira Warren, Oleksandr Hietsoi, and Andrienne C. Friedli

Abstract:

Molecular tweezers are specialized receptors featuring two identical, flat pincers separated by a spacer group. This design facilitates guest binding by enforcing an ideal distance, approximately 7 Å, between the pincers for the intercalation of planar aromatic molecules. Such host-guest systems have significant applications in sensing specific guests. In this study, tetrameric Cu molecular tweezers (TT) were synthesized via the hydrothermal reaction of $Cu(pdc)(H_2O)_3$ and 1,4-dipyridyl-4-(benzene) (DBP) in a 1:1 ratio. The reagents were heated in water at 120°C for 24 hours in a Teflon lined stainless-steel pressure vessel and cooled slowly to yield large blue crystals. The method demonstrated broad tolerance for reagent concentration. The more soluble bimetallic side product could be removed by extraction with DMSO. The X-ray structure of TT showed two sets of perpendicular tweezers per host molecule. The sandwiching of TT with p-rich guests, such as polycyclic aromatic hydrocarbons (PAHs) was expected to diminish the fluorescence of both the guest and host. To investigate these interactions, we evaluated guests with well-defined fluorescence profiles distinct from the host to allow detection of binding through fluorescence quenching. Since TT has an excitation wavelength (278 nm) it overlaps with high energy bands in anthracene (258 nm) and pyrene (270 nm), the emission of TT also includes anthracene (358 nm) or pyrene (320 nm), respectively. In this presentation we will show UV and fluorescence titration of TT with anthracene and pyrene solutions and quantify the interactions.

Poster 110: Cryptococcus neoformans Increases Host Macrophage Glycolytic Flux via HIF1 signaling in an in vitro Pulmonary Infection Model

Presenter: Derek Wiggins
Major: Molecular Bioscience
Department: Biology
Faculty Mentor: Dr. David Nelson

Abstract:

Cryptococcosis is a potentially deadly lung infection primarily caused by the fungal pathogen Cryptococcus neoformans. This pulmonary mycosis disproportionately affects immunocompromised people, and is responsible for 147,000 deaths annually, primarily from meningoencephalitis. While historically known as an AIDS-defining illness, cryptococcosis also occurs in individuals taking immunosuppressive medications (e.g., transplant, cancer, and autoimmune disease patients). Furthermore, the increased incidence of clinical isolates resistant to antifungals and difficulties associated with implementing effective treatment regimens have led to C. neoformans being placed on the World Health Organization's fungal priority pathogens list as one of four 'critical threat' pathogens, holding the highest perceived risk to public health.

Macrophages serve as the first line of defense against cryptococcal infection. Pathogenesis starts with the inhalation of C. neoformans propagules into the lungs, where they are phagocytized by tissue resident alveolar macrophages (AMs), and the dynamics between these immune cells and C. neoformans are important in shaping infection outcome. However, there are challenges associated with studying this interaction in vitro due to difficulties maintaining primary AMs ex vivo. As a potential solution to this issue, in this study we tested the recently developed Fetal Liver-derived Alveolar-like Macrophages (FLAMs) as an alternative AM model.

Our preliminary analysis showed that the steady-state transcriptome of FLAMs was more similar to AMs than PMs, J774, or the macrophage-like cell lines, RAW264.7 and J774, justifying their usage as an AM model. This was followed by a comprehensive multi-tier approach, employing RNA sequencing, biochemical analysis, and live cell imaging, comparing the response of FLAMs and J774 cells to C. neoformans infection. The resulting data provided evidence that FLAMs increased glycolytic flux during C. neoformans infection, and this shift in immunometabolism is partially facilitated by HIF1 signaling. Further study is warranted to determine the specific role played by HIF1 in this context.

Poster 111: Relating Type III Solar Bursts to Ionospheric Fadeouts

Presenter: Camryn Welborn
Major: Physics
Department: Physics and Astronomy
Faculty Mentor: Dr. Chuck Higgins

Abstract:

The purpose of this research project is to explore and quantify the relationship between Type III solar radio bursts and ionospheric fadeouts using data collected from Radio Jove telescopes. Type III bursts are frequent solar radio emissions produced by electron beams propagating through the solar corona and are observable in the 15-30 MHz range as rapidly drifting signals. When the radiation from these bursts reaches Earth, X-rays and extreme ultraviolet emissions increase ionization in the ionosphere, causing fadeouts that can disrupt long distance radio communications. Type III bursts are characterized by their sharp, downward drifting spikes in the spectral radio data. The analysis of these bursts focuses on correlating fadeout duration with the three variables, frequency, fadeout depth, and solar zenith angle. Each fadeout event is divided into two phases: blackout duration and recovery duration based on antenna temperature thresholds. Results thus far suggest that solar zenith angle exhibits the strongest relationship. This research can help us improve our understanding and predictions of ionospheric disturbances caused by solar activity.

Poster 112: The snake fungal disease pathogen (Ophidiomyces ophidiicola) influences the evolution of the skin microbiome

Presenter: Ian Wilson
Major: Biology
Department: Biology
Faculty Mentor: Dr. Donald Walker

Abstract:

Identifying evolutionary and ecological influences on host-microbiome interactions and their role in host health represents an effective means for wildlife conservation. Exploring how pathogen-induced dysbiosis influences a host's microbiome over time can be challenging given a lack of experimental control. Using a controlled experimental evolution design, we characterized variation in bacterial fitness, morphology, and system relationships for two snake skin microbiome residents (Stenotrophomonas maltophilia and Chryseobacterium sp.) in response to metabolites of 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 replicate strains independently and in coculture for ~250 generations to allow for genomic changes to accumulate in response to the experimental medium. A differential effect of fungal metabolites on the growth of derived bacterial strains was observed, as well as variable fitness effects in strains grown in coculture on media simulating dysbiotic snake skin. These findings lay the foundation for future targeted experimentation to gain a deeper understanding of the snake host-microbiome-pathogen tripartite interactions and the impact of pathogen-induced dysbiosis on the evolution of the snake skin microbiome.

Poster 113: Waiting to Feed: Interspecies Dynamics and Feeding Latency at Deer Carcasses in Black and Turkey Vultures

Presenter: marjoni Williams
Major: Biology
Department: Biology
Faculty Mentor: Dr. Danielle D. Brown

Abstract:

Competition is a key concept in evolutionary and ecological theory, predicting that when two species share the same trophic level and diet, one will either experience competitive exclusion from resources or demonstrate niche partitioning. Turkey Vultures (Cathartes aura) and Black Vultures (Coragyps atratus) are both scavengers and frequently feed together at a carcass, raising questions about whether their interactions are competitive or could possibly be cooperative. I analyzed time-stamped trail camera photos and videos of vultures feeding on deer carcasses recorded between 2021 and 2024 at the MTSU Outdoor Forensic Facility. To investigate patterns in vulture feeding behavior, I documented the presence of “waiting behavior," in which vultures arrive at a carcass but appear to delay feeding. For each observation, I recorded the species present, the feeding activity (1 = feeding, 0 = not feeding), and the latency to feed. The hypothesis is that turkey vultures and black vultures facilitate resource access for one another instead of competing at deer carcasses.

Poster 114: A look at how changes in soil alter arena surface factors

Presenter: Anelise Wilson
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

Arenas are the standard for various levels of equine performance, and often made of a sand, silt, or clay combination. Within a day, footing surfaces can be altered by surface composition, discipline, maintenance, and environmental exposure. The interaction between a horse's hoof and surface particles can impact limb forces, hoof slide, hoof grip, and risk for injury. Our study aims to explore the changes to soil properties created by environmental effects, offering insight into surface selection and better management strategies. We hypothesize that factors like temperature changes, dragging, and arena use could alter shear stress. Soil collections will be taken from five arenas within an 80 kilometer radius of Middle Tennessee State University, from April to June 2026. An Uhland sampler, with a 143 cm3 cylindrical core, will be used every other week to make collections three times per day (08:00, 12:00, 16:00). Each collection will be analyzed for bulk density, particle size distribution, pH, soil organic carbon, nutrient element composition (Na, K, P, Ca, and Mg), moisture, soil shear stress, and soil textural analysis. Volumetric water content and penetration resistance of each soil will be gathered at each sampling time, prior to soil collection. External temperature will be recorded at each collection, using a bulb globe temperature gauge. Arena maintenance before or between collections will be noted. Arena owners will receive a 10-minute survey related to their arena management strategies prior to the first day of sampling. We anticipate changes in temperature and humidity will lead to changes in shear stress of a surface. Changes in shear stress may be mitigated by increased arena maintenance techniques, such as dragging, or a lower arena use. Analysis results will be submitted for publication to better support the industry's understanding of arena surfaces.

Poster 115: Examining the Usefulness of AI for Flight School Safety.

Presenter: Gavin Wilson
Major: Aerospace
Department: Aerospace
Faculty Mentor: Dr. Andrea Georgiou.

Abstract:

One of the most important data sources for Safety Management Systems (SMS) is the submission of narrative safety reports by aviators. For the success of any SMS, it is necessary that reports be interpreted accurately and efficiently for contributing factors and key lessons. While airlines have benefited from large safety infrastructure, funding, and resources, collegiate aviation programs have not seen the same benefits. Collegiate aviation programs operated in a high-risk environment characterized by student fatigue, high workload, low levels of experience, limited staffing, and less funding. As of recent, artificial intelligence (AI) has become widely available at little or no cost while being able to perform complex analytical tasks, including the classification of aviation narrative safety reports into Human Factors Analysis and Classification System (HFACS) categories. Despite this potential, little empirical research has directly provided evidence of how AI-generated safety analyses compare to those produced by trained aviation safety professionals within an active SMS.

This study explores the effectiveness of multiple AI platforms in analyzing anonymized safety reports from a collegiate aviation program. Each safety report will be reviewed by three AI systems using the same prompts, and their conclusions will be formatted into a consistent, uniform format. These AI-generated analyses will then be compared to the original human safety analysis through a blind survey conducted with the aerospace faculty members. Based on the original safety reports, participants of the survey will assess which analysis most accurately identifies the contributing factors and key takeaways.

By directly comparing AI outputs with human evaluations, this research aims to determine whether AI can perform one of the most timely analytical tasks within SMS at a level comparable to that of safety professionals. Findings will contribute empirical evidence to the growing discussion of AI integration in aviation safety and evaluate AI's potential as a cost-effective tool to enhance collegiate aviation safety programs.

Poster 116: Development of Open Access Educational Videos for Ranch Horse Competitors

Presenter: Michaela Winslow
Major: Horse Science
Department: Agriculture
Faculty Mentor: Dr. Alyssa Logan

Abstract:

Online education has become increasingly popular, in part due to the Covid-19 pandemic, which forced schools and businesses to develop remote strategies. The equine industry has also experienced growth in online training platforms such as Horse IQ, Horse and Rider on Demand, and Extension Horse Incorporated. Professionals in the Tennessee Stock Horse organization, which hosts ranch horse competitions, expressed interest in an educational program for its members. Ranch horse shows give members a place to show off their horses' ability to work a cow, navigate trail obstacles, and perform advanced patterns representative of tasks completed on a working ranch. The objective of this project was to develop open-source educational videos for ranch horse exhibitors. Photos and videos were gathered at the 2025 Tennessee Stock Horse Association shows, as well as during Middle Tennessee State University's Stock Horse Team practices. Middle Tennessee State faculty and students were featured in videos that included interviews and specialized competition knowledge. Videos were created and adapted to include voice-overs, open captioning, and subtitles. Completed videos were published on YouTube, Facebook, and Instagram to ensure public access and visibility. The videos provided detailed education on the Tennessee Stock Horse Association classes, equipment rules, interpretation of judging cards, and horse judging. Content engagement ranged from 900-3,700 views per individual video. Members reported increased understanding of the organization's rules regarding equipment and classes, as well as judges' expectations. This project focused on creating open-access educational videos that will serve as a resource for the ranch horse community. The educational content was designed to benefit a regional-based ranch horse organization. In future work, educational videos will be developed to serve a nationwide audience.

Poster 117: Analysis of landfill contaminants in air, water, and soil samples

Presenter: Meleia Wolvington
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Dr. Ngee Sing Chong

Abstract:

Middle Point Landfill is a known location for chemical leaching. Soil, water, and air samples were taken from the landfill and surrounding areas and tested for harmful contaminants. Gas samples were collected using 6-liter canisters, and the chromatography-mass spectrometry (GC-MS) method was used in the untargeted mode for analytical measurements of landfill pollutants. Canister samples are analyzed using a cryogenic preconcentrator with a glass bead trap and a Tenax TA sorbent trap prior to being injected into the GC-MS with a 100% polydimethylsiloxane column via cryofocuser. Soil and water samples were collected from locations around Middle Point Landfill and prepared for analysis using solid phase extraction (SPE) cartridges. These samples were analyzed using the Agilent 8890/5977 GC-MS. Major compounds detected in samples include petroleum hydrocarbons, and aromatic compounds such as benzene, toluene, ethylbenzene, and xylenes. Hydrocarbons such as pentadecane, octadecane, hexadecane, and octacosane were found in the soil and water samples. Odor-masking compounds containing trimethylsilyl groups were tentatively identified in water samples. Compounds such as caprolactam and imidizo-[1-2-a] pyrazine were found in soil samples. Linear and cyclic siloxanes compounds found in air, soil, and water samples. Standards of the tentatively identified compounds were prepared in six different parts per million (ppm) concentrations and analyzed with GC-MS under the same conditions as the samples and compared to the tentatively identified compounds. A calibration curve was created by plotting the peak areas of the standards against their respective concentrations. The calibration was referenced against the peak areas and retention times of the tentatively identified compounds in the samples to confirm identification as well as concentration in the samples.

Poster 118: Planktonic and Biofilm Growth Inhibition by (Poly)aspartic acid and Oleic Acid antimicrobial coatings

Presenter: Matthew Wolvington
Major: Biochemistry
Department: Chemistry
Faculty Mentor: Justin Miller

Abstract:

(Poly)aspartic acid (PAA) is a potential biodegradable alternative to commercial plastics that is being investigated as a way to inhibit bacterial growth. Previously published research showed varied levels of growth and biofilm inhibition of Pseudomonas aeruginosa in the presence of thermally synthesized (poly)aspartic acid (tPAA) and Oleic Acid (OleA) antimicrobial coatings. Here we investigate the effects of varying ratios of tPAA to OleA in lower and higher concentrations on the growth of Escherichia coli BL21(DE3)pLysS. This strain of E. coli was genetically modified to express PahZ1KT-1, an enzyme that breaks down tPAA to (oligo)aspartic acid, so we also report on the difference in growth with and without isopropyl β-D-1-thiogalactopyranoside (ITPG), which is a mimic of allolactose to stimulate expression of PahZ1KT-1 by the lactose operon. Additionally, tPAA and OleA ordered sequential coatings were tested against Acinetobacter baumannii, Enterococcus faecalis, and E. coli ATCC 25922, measuring 12-hour planktonic growth and 24-hour biofilm growth. We also compare the microbial inhibition in these compounded coatings to the effects of the individual compounds. These simple, effective coatings show promise as we look for potential methods of preventing bacterial infections.

Poster 119: Glutathione Detection via “Turn-on / Turn-off” Mechanism with Black Carbon Dots and Cu(II) Ions

Presenter: jacob wolvington
Major: Chemistry
Department: Chemistry
Faculty Mentor: Charles Chusiue

Abstract:

Black carbon dots (BCDs) are zero-dimensional nanomaterials with fluorescent and electrochemical properties. They can be synthesized using a “top-down” approach. Top-down carbon dots are chiseled into nanoparticles from larger carbon-based materials using harsh chemicals. BCDs fluoresce across a wide range of excitation wavelengths. Using carbon dot fluorescence, a “turn on/turn off” mechanism is observed. Cu2+ ions bond to the black carbon dot’s quenching their fluorescent signal. In water adding glutathione (GSH) recovers some of the fluorescent signal. GSH acts as a strong reducing agent. The thiol group pulls the Cu2+ ions off the BCD’s structure. The Cu2+ ions quench the fluorescence because the structure formed between the BCA and Cu2+ doesn’t fluoresce. When GSH pulls the Cu2+ ions off the BCDs, less Cu2+ is bonded to the BCDs, therefore they can fluoresce again. Glutathione is an antioxidant produced by the body to respond to oxidative stress. It most commonly appears in concentrations of 2– 20 μM in plasma cells, 1-2 mM in cytosol, and up to 10 mM in liver cells. Being able to monitor GSH levels allows for an understanding of cellular health.

Poster 120: Bioinformatic Characterization of Mutations Associated with Enhanced Acetate Metabolism in Escherichia coli

Presenter: Madison Yahn
Major: Biology
Department: Biology
Faculty Mentor: Elliot Altman

Abstract:

The conversion of non-food lignocellulosic biomass, such as from trees or grasses, into sugars that can be converted into ethanol by fermentation is key to the future U.S. energy infrastructure. The accumulation of acetate during lignocellulosic biomass pretreatment inhibits microbial fermentation and limits bioethanol yields. This study aimed to characterize Escherichia coli strains engineered to efficiently utilize acetate as a sole carbon source to support acetate detoxification prior to yeast fermentation. Eight mutant strains were generated using either spontaneous or ethyl methanesulfonate (EMS) mutagenesis, then characterized using whole-genome sequencing and comparative bioinformatic analysis. Variant detection was performed using two pipelines, Bowtie2 + bcftools and Bowtie2 + DeepVariant, to evaluate differences in sensitivity and precision. The mutants exhibited enhanced growth on acetate despite lacking mutations in acetate metabolism genes (acs, pta, ackA). Instead, changes occurred in genes associated with replication and potentially global regulation of gene expression (dnaA), acid resistance (gadX), glycogen metabolism (glgX), membrane stability (ytcA), and proton export (ECOLC_RS20895). These mutations collectively improved stress tolerance, pH homeostasis, and metabolic efficiency. The results suggest that global physiological remodeling, rather than direct enzymatic modification, underlies enhanced acetate assimilation in E. coli, providing a genetic foundation for designing robust microbial strains for bioethanol production.

Poster 121: Developing quantum embedding cluster approaches to study disorder effects in quantum materials

Presenter: Patrick Wong
Major: Computational and Data Science
Department: Physics and Astronomy
Faculty Mentor: Dr. Hanna Terletska

Abstract:

The Anderson localization (AL) of electrons in disordered media continues to receive increasing interest due to the strong impact of the disorder on quantum materials. However, despite extensive studies, numerical simulations of the influence of strong disorder remain challenging. We use two kinds of recently developed cluster embedding methods to study strong disorder effects. These methods include the real space cluster extension of the typical medium theory (cluster-TMT) and the momentum-space cluster DCA (TMDCA) to study Anderson localization. Applying the developed methods to the Anderson tight-binding model with different types of disorder distributions, we demonstrate that both cluster methods successfully capture the localization phenomena in all disorder regimes as cluster size increases. However, we find different accuracy and cluster size convergence of developed embedding frameworks. We also present new results for the 3D cluster-TMT and TMDCA methods and newly developed results for the 2D cluster-TMT and TMDCA methods. These new results for the recently developed methodologies continue the foundation of studying Anderson localization at real materials within quantum embedding theories.

Poster 122: From Content Coverage to Structured Engagement: Faculty Instructional Change in LA-Supported STEM Courses.

Presenter: Monsour Zakariyah
Major: Mathematics and Science Education
Department: Chemistry
Faculty Mentor: Katy Hosbein

Abstract:

The Learning Assistant (LA) model has been implemented in many undergraduate STEM courses to increase student engagement. While prior work has largely focused on student outcomes, less attention has been paid to how faculty describe their own instructional shifts while working with LAs. This qualitative study examines how STEM instructors (biology, chemistry, and mathematics) at Middle Tennessee State University reflected on changes to their teaching practices within an LA-supported course structure. Faculty Learning Community (FLC) meeting transcripts were analyzed using Community of Practice and Schön's reflective practice as analytic lenses. Coding attended to mutual engagement, shared instructional practices, joint enterprise, and both reflection-in-action and reflection-on-action.

Participants described multiple adjustments to instructional pacing and structure. Several reported intentionally chunking content, reducing lecture depth, and increasing structured peer interaction. Instructors also described real-time modifications during class when they noticed disengagement, as well as post-semester redesign plans intended to improve early student buy-in and participation in review sessions. Shared routines, such as structured feedback cycles before exams, were described as informing instructional redirection. Faculty emphasized that LA presence broadened the classroom's reach and increased some students' comfort levels in engaging with course material. In one course, the fourth exam mean increased by approximately 10 points following changes to structured engagement, though participants noted that multiple contextual factors likely contributed. Within this institutional context, LA partnerships appeared to create structured opportunities for faculty reflection on instructional practice. These findings contribute to understanding how LA-supported environments may support pedagogical refinement in content-intensive STEM courses.