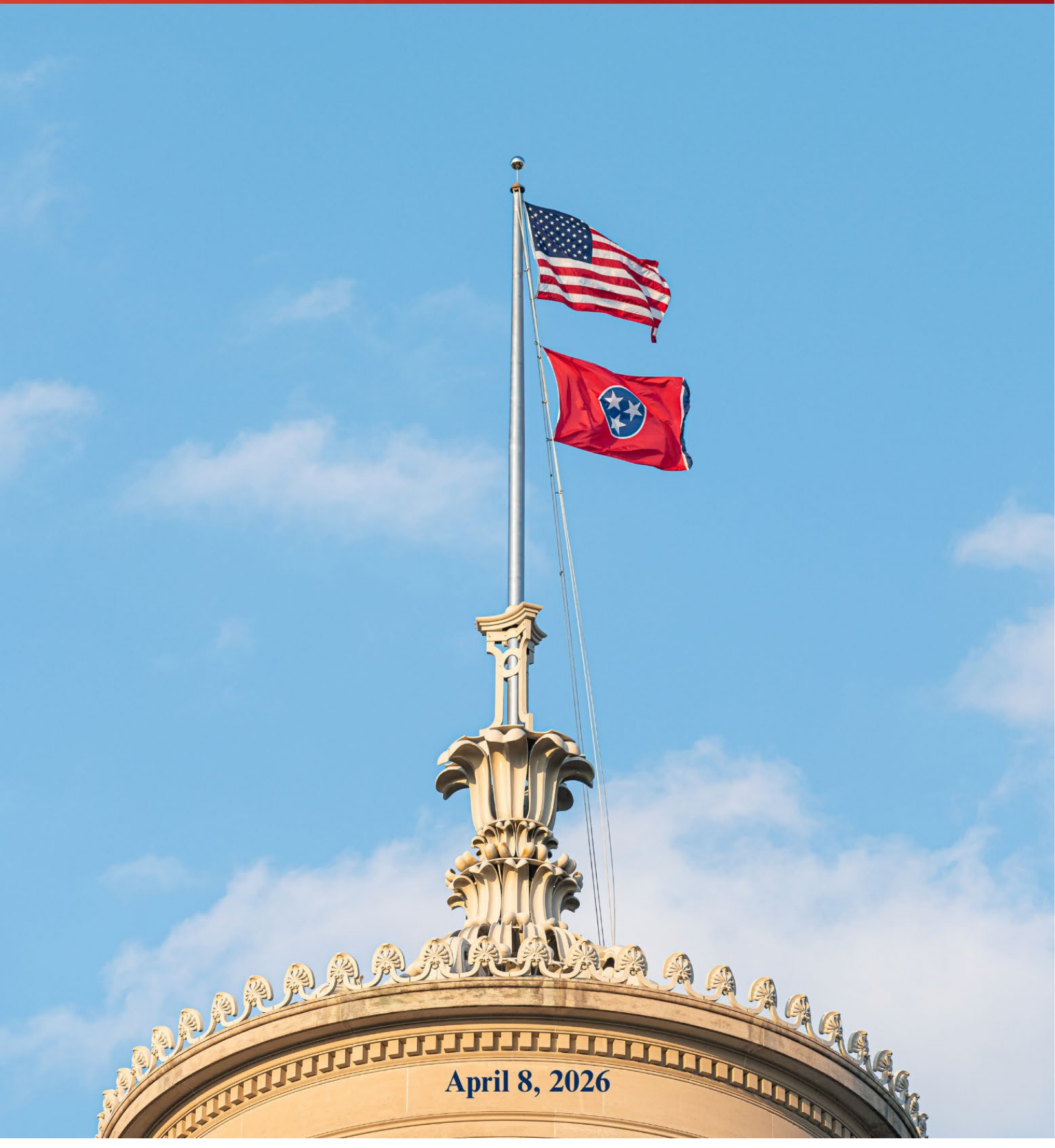
Posters at the Capitol

Hosted by the Tennessee STEM Education Center, MTSU

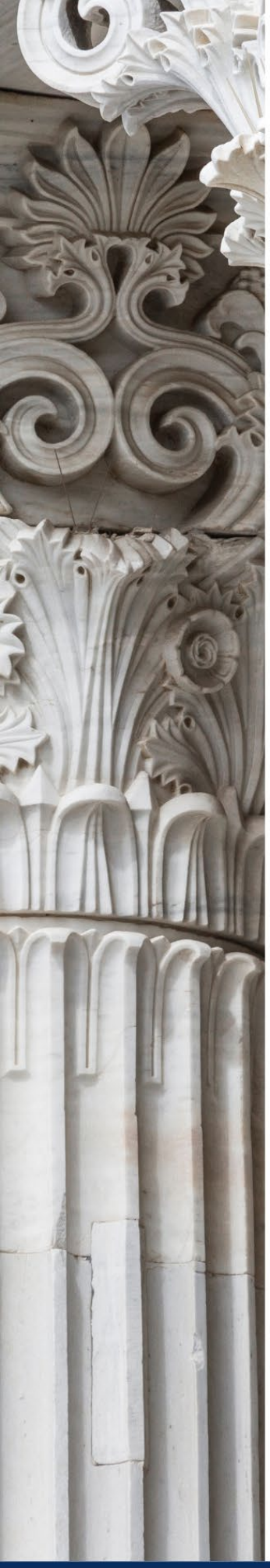
Undergraduate Student Research



April 8, 2026

Participating Universities

Austin Peay State University
East Tennessee State University
Middle Tennessee State University
Tennessee Tech University
The University of Tennessee at Chattanooga
The University of Tennessee at Martin
The University of Memphis



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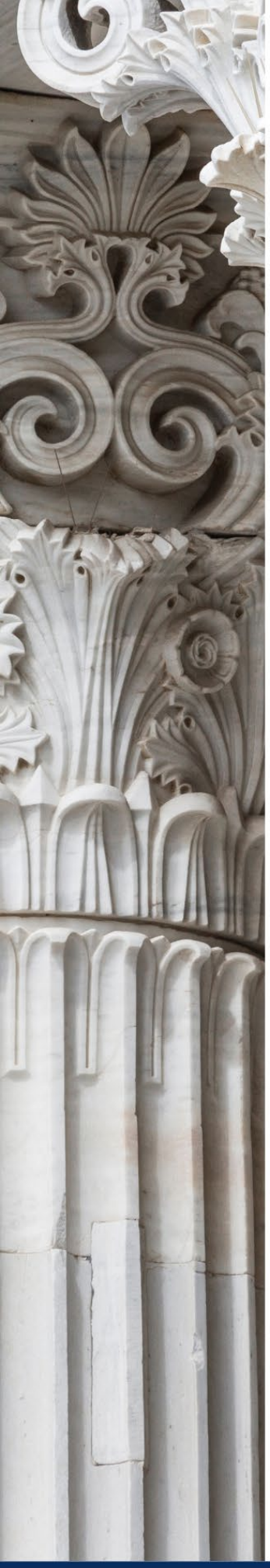

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WELCOME *from the* GOVERNOR

Dear Friends,

I am honored to welcome students from all across the University of Tennessee and Board of Regents systems to the Capitol for the annual Posters at the Capitol event.

This event provides a great opportunity for some of our brightest young minds to present their research to lawmakers. By sharing ideas and working together, we can unleash the extraordinary problem-solving potential of Tennessee. I believe education is the key for Tennessee to lead the nation, and I hope your participation in this event is an enriching experience that inspires you to further academic achievement.

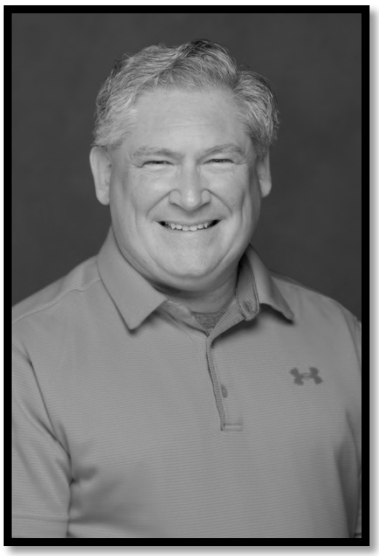
Again, welcome to the annual Posters at the Capitol event. Maria and I send our best wishes for a successful event.

Sincerely,

Bill Lee

Bill Lee

Welcome from Austin Peay State University



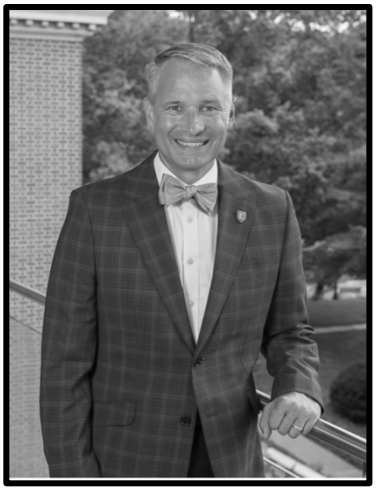
Michael Licari, President

At Austin Peay State University, we're proud to highlight the remarkable research and creative work our students are producing across every discipline. Their curiosity, innovation, and drive are at the heart of who we are as an institution. In 2026, APSU continues to expand opportunities for student scholarship through our Centers of Excellence, the Institute for National Security and Military Studies, and hands-on research experiences embedded throughout our academic programs.

We want our Governors to think boldly and beyond our campus borders—and during this year's Posters at the Capitol event, you'll see just how far their ideas are reaching. Their projects reflect meaningful collaboration with our exceptional faculty experts, who guide, mentor, and challenge them to push the boundaries of their fields.

The APSU Office of Student Research and Innovation (OSRI) remains a cornerstone of this work, providing the mentorship, funding, and connections students need to pursue impactful research and find valuable partners. It's easy to see the promise in their projects, and we're committed to investing in them—because we know their discoveries and creativity will help strengthen our region, our state, and our world

Welcome from East Tennessee State University



Brian E. Noland, President

Since its founding in 1911, East Tennessee State University has been focused on a singular mission: to improve the quality of life for people in our region — and beyond.

At ETSU, we believe education and innovation should go beyond the classroom. From industrial research labs to rural health clinics and hospitals; from forests and waterways to underground archeological digs at our unique Gray Fossil Site; from downtown streets to mountain backroads, our undergraduate researchers are rolling up their sleeves, putting their ideas to work, and making a meaningful difference in the world.

As a premier R2 research university — one pursuing excellence in teaching, service, and research —ETSU has continued to climb in national Higher Education Research and Development (HERD) rankings. In 2024 alone, ETSU secured more than $71 million in research and sponsored program awards. Through our Honors College, our Undergraduate Research Honors Programs, the annual Dr. Jay W. Boland Research Day, and many other initiatives, our students are immersed in research and creative activities. They are supported by our outstanding ETSU faculty, who serve as trusted mentors, guiding our students throughout their journeys of discovery.

This annual event at the Capitol is an opportunity to showcase some of the outstanding scholarly endeavors occurring on our campus. On behalf of the entire campus community, I would like to offer our sincere gratitude to Governor Lee and members of the Tennessee General Assembly for their support and interest in the achievements of undergraduate researchers across the state.

Godspeed, and go Bucs!

Welcome from Middle Tennessee State University

Sidney A. McPhee, President

The second goal of our university's Academic Master Plan is to promote individual student success and responsibility for accomplishments through fostering a student-centered learning culture. Creating a culture of research and inquiry for undergraduates through a campus-wide initiative that engages students in a journey of discovery through exploration of real-world research problems is a strategic direction that supports this goal. Our Undergraduate Research Center coordinates students' research efforts across the campus by encouraging participation through initiatives such as the Honors College, FirstSTEP, TLSAMP, URECA, and other student research experiences. Posters at the Capitol, an event that has been awarded TBR's Academic Excellence Award, is an exciting forum to share our students' work with state legislators.

Our commitment to undergraduate students participating in research is unwavering. I think the quality of the abstracts in this booklet and the posters exhibited at the Capitol will convince you that our resources and efforts are not misplaced. MTSU is delighted to participate in the Posters at the Capitol event.

Welcome from Tennessee Technological University

Philip B. Oldham, President

Welcome to the Posters at the Capitol. Congratulations to all the participating students and thank you to all those supporting their efforts. Discipline-based, independent creative scholarship and research is the heart and soul of any modern education. To actively learn by doing is the ultimate educational experience and often the real differentiator for employment in this highly competitive global economy. From my personal experiences participating in research as an undergraduate and supervising many student research projects in my career, the challenge of original research provides significant and lasting personal benefits regardless of the initial results or project outcome.

As Tennessee's Technological University, TTU is proud of its long history in research and creative scholarship. Undergraduate research is an integral part of the educational experience provided to our students regardless of their academic major. One of the most rewarding parts of the research experience is the chance to share your discoveries with your peers and other colleagues at events like this. Best wishes to all the outstanding apprentice scholars participating.

Welcome from The University of Tennessee

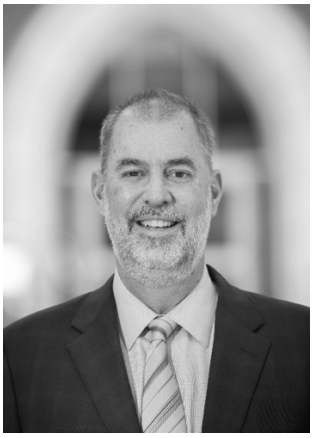
Welcome to Posters at the Capitol! This important program is a reminder that the research conducted across the University of Tennessee System improves lives in our great state. I often say the University of Tennessee exists to serve the state of Tennessee. With campuses in Knoxville, Chattanooga, Martin, Pulaski and Memphis, along with the statewide Institute of Agriculture and Institute for Public Service, the UT System is uniquely positioned to address the grand challenges of our time.

Posters at the Capitol is a special celebration of the innovative spirit of undergraduate students and their dedicated faculty mentors. The projects you'll see today showcase groundbreaking research and creative achievements that reflect the passion, curiosity and drive of our students. These scholars ask "why" and pursue "how" to tackle everyday challenges in fields ranging from science and technology to the humanities.

Students at the University of Tennessee benefit from access to world-class facilities, cutting-edge expertise and meaningful collaborations. Partnerships and collaborations with the Oak Ridge National Laboratory and the UT Oak Ridge Innovation Institute and private-sector collaborations enrich their research and expand its impact, making discoveries that shape the way we live, work and understand the world. I am grateful for the opportunity to share the remarkable work of these students with our state's leaders and the public. Their dedication and achievements remind us that the future of Tennessee is brighter than ever.

Randy Boyd
President, University of Tennessee System

Welcome from the University of Tennessee at Chattanooga



Robert Dooley, Interim Chancellor

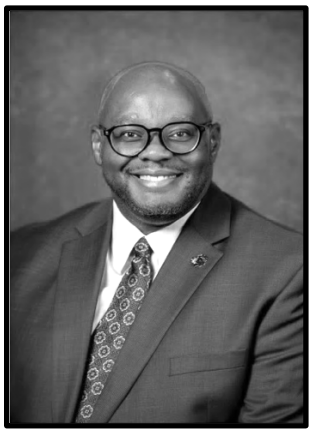
Welcome to Posters at the Capitol! The University of Tennessee at Chattanooga is proud to celebrate the achievements of our undergraduate students whose dedication to research and discovery embodies the spirit of our campus.

At UTC, we believe that the journey of learning extends far beyond the classroom. It's about exploring new horizons, making meaningful contributions and preparing for a world of endless possibilities—and undergraduate research is a cornerstone of that journey.

Through these research experiences, students not only expand their knowledge but also cultivate critical skills for thriving in an interconnected, global society. The Office for Undergraduate Research and Creative Endeavor (URaCE) is dedicated to making these transformative experiences accessible to every student—regardless of background, field of study or stage in their academic journey.

Today, we celebrate the curiosity, creativity and commitment of our students. Thank you for joining us in recognizing the promising futures they are building.

Welcome from the University of Tennessee at Martin



Yancy Freeman, Chancellor

Greetings from the University of Tennessee at Martin and welcome to the Posters at the Capitol Program! We are incredibly proud of all the students who will display their work, but I am thrilled about the work of UTM students. Undergraduate research is an intricate part of the experience for UTM students, and we pride ourselves on developing solutions to real world problems. Our faculty are well accomplished in their field of study, and they help students to expand knowledge and understanding across several disciplines through our research opportunities. Students in agriculture, business, behavioral sciences, humanities, STEM and healthcare have tremendous opportunities to engage in transformational research. UTM students are gaining invaluable practical experience and insight into improving our community and the world.

We are proud to present these selected research projects to represent ongoing undergraduate research opportunities in STEM at UT Martin.

Welcome from The University of Memphis

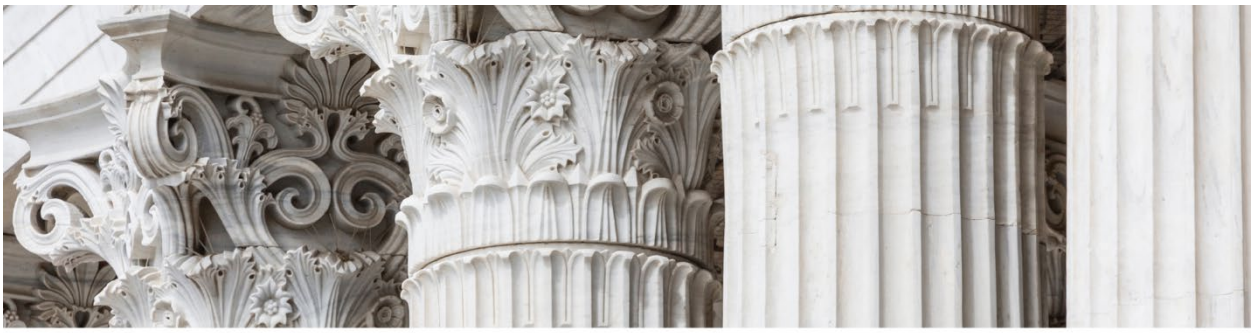
Bill Hardgrave, President

The University of Memphis extends its congratulations and well wishes to all students participating in the annual Posters at the Capitol event. It is a prestigious honor to present your research to legislators and guests at the Tennessee State Capitol, and we recognize that being selected to do so is a testament to your impressive commitment and achievements.

As a Carnegie R1 University, the UofM prides itself on being one of the top-tier research institutions in the country. We are dedicated to maintaining and continually building upon our research status, and advancing undergraduate research is an essential part of our institutional mission. Posters at the Capitol is a terrific celebration of the students who are actively making those advancements.

We greatly appreciate our State of Tennessee legislative representatives for hosting this event and acknowledging the hard work of these students.

Posters by Poster Number



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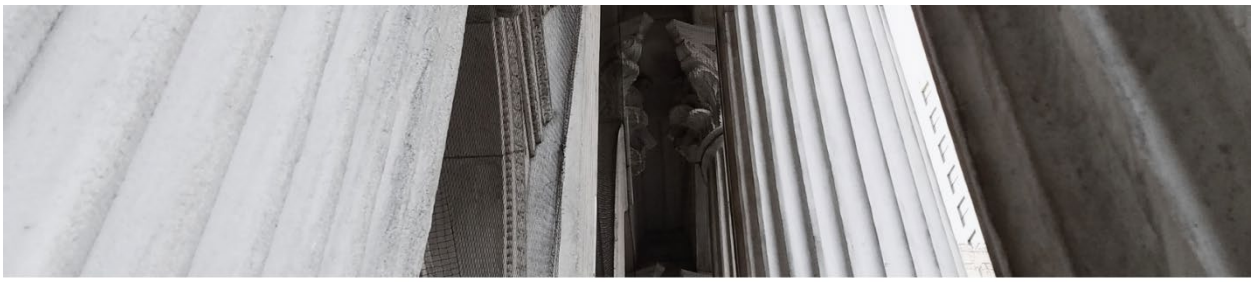

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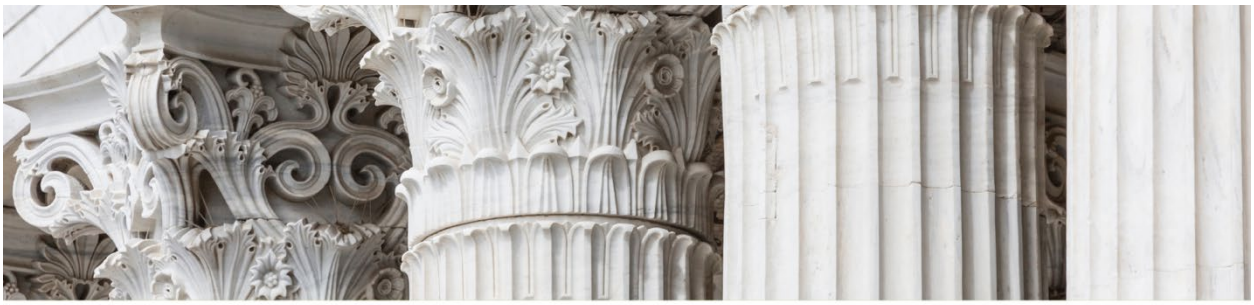

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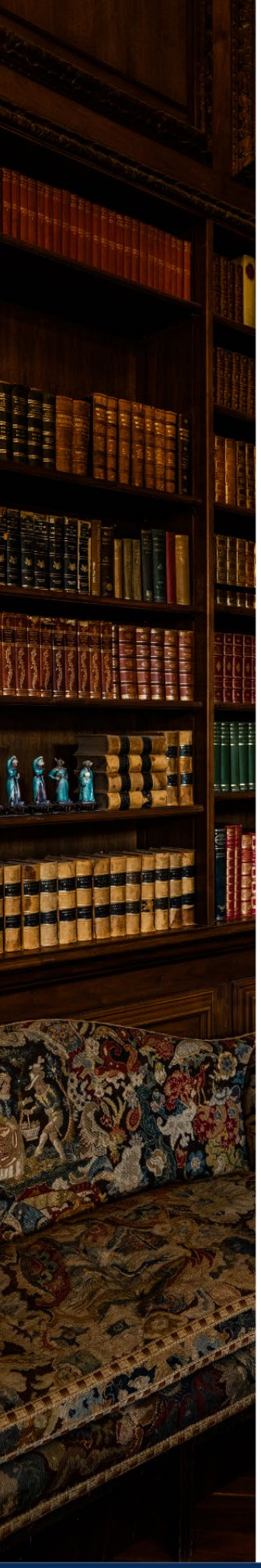
Williams, Ryan	Krishi Patel	TTU	30



Poster Abstracts

1. Christian Bourn
Austin Peay State University
Faculty Mentor: Dr. Daniel Mayo

Modeling Thermal Transfer and Dissipation in an Ignited Sparkler

This research developed a predictive mathematical model of thermal transfer in a burning sparkler by implementing a computationally efficient, iterative approximation of the one-dimensional heat equation and Newton's law of cooling. This framework enabled precise mapping of thermal energy propagating along the metallic wire while accounting for atmospheric dissipation. The model revealed an unexpected phenomenon: upon the conclusion of the burn, the hottest location on the sparkler migrates upward along the previously burned wire. To verify the model, we collected real-world data using a Forward Looking InfraRed (FLIR) camera equipped with a specialized Germanium lens capable of measuring temperatures exceeding 2,000 degrees Fahrenheit. The camera tracked the hot spot along a lit sparker and showed the same progression as predicted by the model. After combustion, the peak thermal intensity travelled upward along the sparkler wire. The strong correlation between mathematical predictions and real-world experimental results confirms the efficacy of iterative approximation methods in modeling complex, high-temperature thermodynamic behavior. Beyond pyrotechnics, this integrated modeling approach has significant potential applications in industrial manufacturing for optimizing the cooling rates of high-performance metal alloy wires, rods, and aerospace components.

2. Tovaria Kee
East Tennessee State University
Faculty Mentor: Dr. Anoop Arunagiri

Palmitate-Induced Lipotoxicity Triggers ER Stress Without Increasing ROS in Pancreatic Beta Cells

Obesity, driven by a Western diet high in fat and fructose and genetic risk factors identified by Genome-Wide Association Studies (GWAS), has risen steadily in the U.S. since 1999. Excess adipose tissue elevates circulating free fatty acids (FFAs), leading to lipotoxicity (LT) and impaired insulin signaling, which causes insulin resistance and glucotoxicity (GT). Together, these processes, or glucolipotoxicity (GLT), promote type 2 diabetes (T2D). To explore beta-cell vulnerability to GLT, we examined how prolonged FFA exposure affects endoplasmic reticulum (ER) and mitochondrial homeostasis. INS1 beta cells treated with 200 micromolar palmitic acid (PA) for 24 hours showed increased proinsulin but decreased total insulin, suggesting defective processing or secretion. Elevated BiP expression indicated ER stress, whereas DCF assays showed no significant changes in reactive oxygen species, implying minimal mitochondrial oxidative stress. These findings suggest that lipotoxic stress primarily disrupts ER homeostasis and insulin maturation, representing an early adaptive response before mitochondrial dysfunction occurs.

3. Emily Callison
Middle Tennessee State University
Faculty Mentor: Dr. David Nelson

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

Cryptococcosis is a severe systemic fungal infection caused by Cryptococcus neoformans (Cn), a facultative intracellular pathogen that disproportionately impacts immunocompromised populations. Within the lungs, Cn infects alveolar macrophages (AMs), innate phagocytes tasked with ingesting and eliminating the pathogen, and manipulates their metabolism to survive and disseminate, ultimately causing fungal meningitis. Specifically, Cn triggers a shift from mitochondrial respiration to glycolysis by activating hypoxia-inducible factor 1 (HIF-1). Our lab has shown that stabilizing HIF-1α with DMOG increases glycolytic gene expression, while inhibition with echinomycin partially reverses this effect, suggesting Cn exploits HIF-1–driven metabolic remodeling to persist intracellularly. We hypothesize that inhibiting HIF-1 with echinomycin will reduce intracellular Cn replication. To test this, we first identified an effective, non-toxic echinomycin dose in J774 macrophage-like cells using qRT-PCR of HIF-1 target genes. These conditions were then applied to fetal liver–derived alveolar-like macrophages (FLAMs), a physiologically relevant AM model. Live-cell imaging will be used to assess how HIF-1 inhibition affects intracellular Cn replication. We anticipate that blocking HIF-1–mediated glycolysis will impair Cn replication and alter antifungal defense, providing insight into pathogen-driven metabolic remodeling and potential therapeutic targets for combating cryptococcosis.

4. Abby Daniel
Tennessee Tech University
Faculty Mentor: Dr. Michael Harrison

A Geochemical Study of Acid Mine Drainage at the Ravenscroft Mine in White Co., Tennessee

Acid mine drainage (AMD) is a biogeochemical process associated with coal and metallic ore deposits. Oxidation of sulfide minerals, especially pyrite, generates sulfuric acid that lowers the pH of surrounding soils, surface water, and groundwater while mobilizing metals such as aluminum, iron, and zinc. In the United States, AMD impacts more than 20,000 km of streams, degrading water quality and biodiversity. The Ravenscroft mine near Sparta, Tennessee, operated from 1902 to 1936. Mining activities brought subsurface waste rock to the surface, forming coal refuse piles. Oxidation of this material produces acidic leachate that infiltrates soil and groundwater and leaves the site as runoff. Although now a historic site with a walking trail, environmental impacts remain. Building on Mofield (2024), who reported acidic leachate with conductivities of 54–281 µS/cm, this study analyzed AMD for more than 20 metals, eight anions, and additional water-quality parameters. Samples collected from May to October 2025 showed pH values ranging from 3.4 to 6.9, with elevated aluminum (up to 14.3 mg/L), iron (13.2 mg/L), and sulfate (157 mg/L). Iron staining is widespread in nearby streams, aquatic life is sparse, and refuse extends beyond the site, indicating potential for broader AMD impacts.

5. Bentley Adkins
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Huu Hoang Nguyen

AI-Powered Collison Risk Assessment Utilizing Ultra-Wideband Enhancement for Urban Mobility

This project aims to develop an AI-driven edge-computing solution for smart intersections, focusing on risk of collision prediction and post-crash detection. By leveraging advanced trajectory prediction, sensor fusion, and federated learning, this initiative will enhance road safety for both vehicles and vulnerable road users (VRUs). This project is a collaboration between DENSO and the University of Tennessee at Chattanooga (UTC). We will be utilizing enhanced micro location technology (Ultra-Wideband) to enhance the real-time location tracking of VRUs while preserving the privacy of the pedestrians. The purpose of using Ultra-Wideband will be used to send real-time messages to enhance traffic safety and emergency response time. Ultra-Wideband can be integrated into a post-crash detection system capable of supporting real-time incident identification.

6. Sara Batts & Seth Hatchett
University of Tennessee at Martin
Faculty Mentor: Drs. Saman Sargolzaei and Ann Gathers

Use of Electroencephalography to Determine the Neurological Activity Associated with Mental Imagery During Distracting Auditory Stimulation

In the recent decades, neuropsychological studies have explored the relationship between cognitive abilities and visual mental imagery vividness. Yet, while previous studies have associated vividness of mental imagery with attentional control, the EEG dynamics underlying mental imagery under distracting conditions remain poorly understood. This study investigated whether theta and beta band power are associated with individual differences in visual mental imagery vividness during auditory distraction. Using questionnaire-based measures, preliminary study results indicated a positive correlation between perceived visual mental imagery vividness and selective attentional control. On an EEG level, differences in theta band activity were detected between individuals with lower and higher visual mental imagery vividness. Specifically, participants with lower imagery vividness exhibited greater increases in theta band power relative to baseline in no- and low-distraction conditions. These findings suggest that EEG spectral dynamics, particularly within the theta band, reflect distinct neural mechanisms underlying visual mental imagery under distraction, with implications for neurocognitive assessment and applied neuroengineering.

7. Asher Hodge
University of Memphis
Faculty Mentor: Dr. Gary Bowlin

Manuka Honey-Enhanced Vascular Grafts for Modulating Neutrophil Inflammation and Improving Patency

Cardiovascular disease is the leading cause of death worldwide, and its burden continues to grow. One of the primary treatment strategies for advanced cardiovascular disease is vascular grafting—used to bypass or replace occluded or damaged blood vessels. While large and medium-diameter grafts have seen improvements in clinical outcomes, the development of small-diameter (<6 mm) synthetic vascular grafts remains a critical unmet need. These grafts are highly susceptible to failure due to thrombosis, fibrous encapsulation, infection, and chronic inflammation at the site of implantation. Despite decades of research, no FDA-approved synthetic small-diameter vascular grafts are currently in clinical use. This project seeks to address this major clinical gap by investigating the immunomodulatory properties of Manuka honey and its bioactive flavonoid components when incorporated into fibrous small-diameter vascular grafts. By focusing on the acute immune response—specifically neutrophil-driven inflammation and oxidative stress—this research aims to reprogram the local host response from chronic inflammation and fibrous encapsulation toward regeneration and successful graft integration. The project integrates techniques in immunology, polymer fabrication, and translational biomaterials.

8. Stephan D. Cooper
Austin Peay State University
Faculty Mentor: Dr. Amy L. Thompson

Limitations and Benefits of Plant Oils for Oral Bacterial Growth Control

Human tooth enamel is made of a hard, mineralized, non-shedding surface, which allows for microbial colonization called dental plaque. Although not well established as effective, some dental health providers recommend the use of essential oils for improved oral hygiene and oils such as peppermint and cinnamon are often found in dental products. The current study focused on the effectiveness of plant oils in reducing bacterial growth of some common oral microbes. While many microbes play a role in plaque formation, this research studied *Staphylococcus aureus*, *Streptococcus mutans,* and *Lactobacillus paracasei*, which ferment sucrose (sugar) and are known to be involved in plaque formation. Many of the oils used in this study are found in oral health products and all have been touted to prevent microbial growth based on their chemical composition. This work showed that oils such as cinnamon and oregano inhibit bacterial growth, whereas oils including rosemary, eucalyptus, grapefruit, lemongrass, mullein leaf, ginger, and lemon had little to no inhibitory effects. Studies like these are important as they show that although there may be some effectiveness with certain oils at preventing certain organisms from growing, oil use is not a substitute for brushing, flossing, and regularly professional dental cleanings.

9. Jackson Leppert
East Tennessee State University
Faculty Mentor: Dr. Matthew Zahner

Selective Ablation of RVLM-Projecting PVN Neurons

The rostral ventrolateral medulla (RVLM) is a brainstem region responsible for basal sympathetic vasomotor tone; the paraventricular nucleus (PVN) controls the RVLM via neural projections. In PTSD and other chronic stress conditions, heightened sympathetic drive causes hypertension and cardiovascular risk. However, the specific contribution of RVLM-projecting PVN neurons to stress-augmented sympathetic activity remains unclear. To define the functional role of this projection, we bilaterally injected a Cre-dependent taCaspase3 viral vector (FLEX-taCasp3) into the PVN and a unilateral retrograde AAV expressing Cre-recombinase into the left RVLM of rats. Cre-recombinase is transported retrogradely to the RVLM-projecting PVN neurons, where it interacts with FLEX-taCasp3; this induces recombination at loxP sites, activating caspase-3, triggering apoptosis, and killing the neurons. In rats receiving FLEX-taCasp3tdTomato, tdTomato labeling was absent in the left PVN, consistent with Cre-dependent ablation of RVLM-projecting neurons, while neurons lacking Cre-recombinase remained labeled. When reviewed under immunohistochemistry (IHC), the right and left amygdala expressed tdTomato, whereas the left PVN did not. These findings indicate successful retrograde ablation of RVLM-projecting PVN neurons expressing the Cre-dependent taCasp3 suicide construct. Given that the RVLM-projecting PVN neurons were selectively removed, these proof-of-concept data allow us to perform neurophysiological experiments to test their role in sympathetic reflex activity.

10. Alexis Katz
Middle Tennessee State University
Faculty Mentor: Dr. April Weissmiller

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

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.

11. Emmy Easterwood
Tennessee Tech University
Faculty Mentor: Dr. Carla Hurt

Creation of a Taxonomic Database of Arthropods in Subterranean Environments in the Bridgestone/Firestone Wilderness Area of Tennessee

Subterranean cave ecosystems harbor unique biological communities characterized by specialized adaptations. However, these ecosystems are highly vulnerable to human disturbance, making biodiversity assessments essential for conservation. Environmental DNA (eDNA) metabarcoding is a powerful tool for surveying vertebrate and macroinvertebrate communities in caves and karst systems. However, the effectiveness of eDNA surveys depends on the availability of comprehensive genetic reference libraries that link eDNA sequences to known species. This project will address this gap by generating a reference library for cave and karst arthropods in the Cumberland Plateau. Specifically, the development of genetic databases for 16S and COI barcodes from arthropods collected at cave eDNA sampling sites. These barcodes will be linked to voucher specimens, providing valuable taxonomic information for cave biodiversity studies. Findings from this study will enhance the accuracy of eDNA metabarcoding for assessing biodiversity and community composition in subterranean habitats and support conservation policies aimed at protecting cave ecosystems in the Cumberland Plateau.

12. Gracie Crooks
University of Tennessee at Chattanooga
Faculty Mentor: Dr. F. Ayca Cetinkaya

Stabilizing Inverse Problems with Regularization and Optimization

Inverse problems arise when we try to recover hidden information from indirect or noisy data. These problems often lead to inconsistent or ill-conditioned linear systems, where least-squares solutions can become unreliable. This project investigates how regularization methods, such as Tikhonov regularization, and constrained optimization techniques can stabilize least-squares solutions. Computational experiments illustrate how these approaches reduce sensitivity to data perturbations and improve solution accuracy.

13. Zachary Wager & Joshua Townsend
University of Tennessee at Martin
Faculty Mentor: Dr. Ali Seyedkavoosi

Design and Modeling of a Low-Cost Tendon-Driven Underactuated Prosthetic Hand

This research presents the design, modeling, and prototype development of a low-cost, tendon-driven underactuated prosthetic hand developed to provide functional grasp performance using accessible fabrication methods. The proposed system addresses the cost and complexity limitations of commercial myoelectric prostheses by employing a cable-driven architecture constructed from high-strength monofilament fishing line as an artificial tendon. Coordinated multi-joint finger flexion is achieved through under actuation, enabling anatomically inspired motion with a minimal number of servo actuators. Analytical models are developed to characterize torque transmission and joint rotation for actuator selection and tendon routing design. All components are designed using computer-aided design tools and fabricated via additive manufacturing (3D printing) with PLA filament to ensure low production cost, rapid prototyping, and reproducibility. Ongoing system-level experimental evaluation focuses on assessing tendon transmission behavior and multi-joint flexion performance across common grasp configurations. The project contributes a manufacturable prosthetic hand platform suitable for educational, research, and resource-limited applications.

14. Keilan Roseheart
University of Memphis
Faculty Mentor: Dr. Amy Abell

Examining the Role of MAP3K4 and HDAC6 on Fetal and Placental Growth in the 129/SvEv Background

Fetal growth restriction (FGR) affects up to 10% of human pregnancies worldwide. FGR is a risk factor for multiple disease states in adulthood, including cardiovascular disease and diabetes. Placental dysfunction is one of the principal causes of FGR. Recently, our lab demonstrated that an enzyme called mitogen-activated protein kinase kinase kinase 4 (MAP3K4) has a critical role in embryonic and placental growth in mice. MAP3K4 kinase inactive mice (*Map3k4*$^{KI/KI}$) also have reduced survival at weaning age, representing 6% of the total population. The few *Map3k4*$^{KI/K}$ mice that survived were significantly smaller than wild-type mice, a hallmark of FGR. We also demonstrated that the enzyme histone deacetylase 6 (HDAC6) is hyperactive and overexpressed in *Map3k4*$^{KI/KI}$ trophoblast stem cells that differentiate into the major cell types of the placenta. However, a role for HDAC6 in normal placental development is unknown. The goal of this project was to test the hypothesis that hyperactive HDAC6 has a role in the lethality and growth restriction phenotype of *Map3k4*$^{KI/KI}$ mice. To test this hypothesis, we genetically deleted *Hdac6* from *Map3k4*$^{KI/KI}$ mice through a breeding strategy with a commercially available *Hdac6* knockout strain from Jackson Laboratory. Using the mice gained from this line, we then bred them and dissected each conceptus from pregnant mice 13.5 days post plug confirmation. These were then imaged, the placentas weighed, and the embryos were genotyped. Our results suggest that deletion of *Hdac6* improved midgestational growth of *Map3k4*$^{KI/KI}$ embryos and placentas. Collectively, our findings demonstrate a previously unidentified role for HDAC6 in embryonic and placental growth in mice.

15. Truong Dinh
Austin Peay State University
Faculty Mentor: Dr. James Church

The Invisible Tunnel: Exploiting Protocol Complexity for Distributed Steganography in IPv6 Extension Headers and Flow Labels

This research explores a novel approach to network evasion by exploiting the inherent complexity of IPv6 Extension Headers (EHs) and Flow Labels for distributed steganography. Unlike traditional research that focuses on disruptive attacks such as Denial-of-Service, this work investigates how the same protocol complexities that have led to system vulnerabilities (e.g., CVE-2024-38063) also create overlooked opportunities for covert data transmission. With the rise of "shadow networks" unmonitored IPv6 traffic in enterprise environments—critical blind spots are emerging in network security. The study demonstrates that data can be hidden across multiple IPv6 packet fields, specifically Flow Labels and PadN options within EHs, thereby evading conventional entropy-based detection methods. Experimental analysis shows that current network security devices, which often bypass deep inspection of EH chains for performance reasons, are ill-equipped to detect such distributed steganographic channels. The research concludes that new Deep Learning-based countermeasures are needed to address these evasion techniques, and highlights the necessity for security teams to scrutinize specific fields in IPv6 packets rather than relying solely on general-purpose monitoring.

16. Trent Lewis
East Tennessee State University
Faculty Mentor: Dr. Tianhu Sun

Unlocking Hidden Nutrition in Seeds with Artificial Intelligence

Hidden hunger is defined as micronutrient deficiencies, and it impacts more than 2 billion people around the world. Seeds are rich in energy, but lack many essential vitamins such as vitamin A. However, soybean seeds contain a phytoene synthase (PSY) gene, and important precursor to beta carotene, with a mostly inactive PSY promoter. Our project aims to aims to unlock the natural potential of soybean seeds to produce vitamin A utilizing a Convolutional Neural Network (CNN) to upregulate the PSY promoter. To do this, we trained our CNN using a set of both seed and non-seed specific gene promoters from genome and transcriptomic data to predict with a 75% accuracy what PSY promoter mutations would increase upregulation. We utilized Gibson Assembly to engineer a pCNHP construct containing the isolated PSY promoter and a RUBY reporter, which causes a color change in plant tissue upon promoter activation. We will utilize targeted mutagenesis to obtain the mutations suggested by our CNN in our construct, and then test the effectiveness of these mutations using floral dipping in Arabidopsis. Eventually, prime-editing will be used on these promoters in soybean seeds to enhance vitamin A concentration without introducing foreign genes.

17. Trenton McAlmond
Middle Tennessee State University
Faculty Mentor: Dr. Tiffany Rogers

Administration of Intracerebral Oxytocin and its Effect on Social Motivation in C57BL/6J Mice

How does the localized administration of oxytocin to the nucleus accumbens of C57BL/6J mice modulate peer-to-peer social motivation? Low social motivation is a characteristic symptom of autism spectrum disorder (ASD). Oxytocin has been proposed as a possible treatment for the social deficits observed in ASD. Yet, clinical trials involving oxytocin produce varied results which suggest context-dependent effects of oxytocin. Utilizing novel behavioral assays designed to measure social motivation, we plan to determine how oxytocin affects rates of peer-to-peer sociability in both high effort interactions and low effort interactions. In order to investigate this effect, we implanted guide cannulas into the nucleus accumbens of C57BL/6J mice. The mice were administered an infusion of either oxytocin or phosphate buffered saline (PBS) and then underwent behavioral testing. Our past research has shown that mice receiving an intranasal administration of oxytocin will exhibit an increased social motivation in a low effort context. However, when high effort is needed, social motivation decreases. We hypothesize that the administration of oxytocin to the nucleus accumbens will result in a similar effect, in which high effort context reduces social motivation and low effort context increases social motivation. Preliminary results suggest that social motivation is decreasing after the oxytocin administration to the nucleus accumbens. These findings support previous research findings in which oxytocin acts to decrease social motivation in peer-to-peer interactions.

18. Arly Mize
Tennessee Tech University
Faculty Mentor: Dr. Jeff Boles

Novel Protein-Binding Dyes Can Improve Protein Concentration Determination

The Bradford protein assay is a widely used technique for protein quantification that is based on the binding of a specific dye to protein, leading to a color change measurable at a wavelength of 595 nm. This study tested the efficacy of various dyes as substitutes for Coomassie Brilliant Blue G-250, the standard dye used in the assay. Dyes evaluated included Rose Bengal, Methyl Orange, and Carmine, among others. Each was selected for their distinct structural and spectral properties in the presence and absence of protein. Proteins such as bovine serum albumin (BSA) and lysozyme serve as test proteins. Each dye's linearity in standard curves, and sensitivity to protein concentration were analyzed using scanning and single-point UV-Vis spectrophotometry. Results will be presented in this presentation. We hypothesize that some will perform sufficiently while others will lack sufficient specificity. The findings will likely highlight the potential for alternative dyes in the Bradford assay since the linear region utilizing Coomassie Brilliant Blue G-250 is often small. Optimization will be necessary for achieving consistency and precision. This study broadens the scope of protein quantification techniques and introduces potential cost-effective alternatives.

19. Brielyn Hallam
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Luis Sanchez Diaz

Rheology of Silica-Bovine Serum Albumin

Silica–protein conjugates possess unique physicochemical properties arising from their nanoscale dimensions, high surface area, and interfacial phenomena, making them promising for applications in biosensing, drug delivery, imaging, and advanced materials design. However, the connection between microstructure and rheological behavior in silica–protein systems—particularly those involving bovine serum albumin (BSA)—remains poorly understood. In this study, we investigate a model system of silica nanoparticles and BSA to elucidate how protein adsorption modulates colloidal interactions and flow behavior in dense suspensions. Rheological measurements reveal pronounced non-Newtonian features, including shear thinning and transient viscoelasticity, reflecting dynamic microstructural rearrangements driven by protein-mediated interactions and shear-induced alignment or clustering. This integrated approach provides new insights into the fundamental mechanisms by which biomolecular adsorption governs the complex structural and flow responses of soft colloidal materials.

20. Sumiran Sharma
University of Memphis
Faculty Mentor: Dr. Jessica Amber Jennings

Colorimetric Dressing for Detection of Wound Infection

Burn injuries are highly susceptible to potential microbial invasion and subsequent infection due to the disruption of the protective skin layer. Challenges such as early excision and skin grafting persist due to slow healing, infections, and burn progression complicate the treatment process and potentially worsens the healing outcomes. Often, antibiotics are used indiscriminately, even without confirmation of infection. This contributes to the development of antimicrobial-resistant strains of microorganisms. The solution to this is based on the detection of a molecule produced specifically by pathogenic bacteria. By incorporating a textile sensor window into a wound dressing, exudate absorbed by a dressing could change color if the wound is infected. The dressings consist of electrospun chitosan membranes, where chitosan is intrinsically anti-inflammatory and anti-microbial. We demonstrated feasibility by showing that small pieces of chitosan membranes with enzyme and substrate adsorbed turned from yellow to purple in the presence of *Staphylococcus aureus* and *Pseudomonas aeruginosa*, two common wound contaminants. This would allow patients and clinicians to monitor the tissue status without having to remove the dressing. The research goals are to optimize fabrication, determine what concentrations of microbes can be detected, and determine how long it takes for color to develop.

21. Justin Edwards
Austin Peay State University
Faculty Mentor: Dr. Daniel Mayo

Deriving Settling Probabilities for Asymmetrical Falling Geometries

Predicting how irregularly shaped objects settle when dropped is a complex challenge in computational physics. For asymmetrical objects, the center of mass is unevenly distributed, which significantly alters how the object bounces and rotates upon impact. Standard software engines often simplify these complex shapes using basic bounding boxes or convex hulls. This simplification can lead to inaccurate predictions of an object's true resting position. The aim of this project is to investigate the dynamics of an asymmetrical "Inuit die" that has a chair-like shape, to accurately predict its resting-state probabilities. The die, referred to as a “ketchu”, was used in traditional Alaska Native games of chance. To capture the precise rotational physics during a collision, we developed a custom physics simulator that builds 3D-pixelated "voxelized" models of the die. Preliminary results indicate our high-resolution voxel method closely matches real-world physical behavior and allows for the derivation of the settling-behavior probabilities of the complex geometry. This computational approach enables enhanced predictive modeling across broad real-world applications, such as tracking the tumbling dynamics of orbital space debris and improving the accuracy of automated manufacturing systems.

22. Zoe McCready Martin
East Tennessee State University
Faculty Mentor: Dr. Tianhu Sun

Modeling Pharming: Using Plant Transformation to Express Therapeutics for Cancer and Autoimmune Diseases

Plant synthetic biology is an emerging discipline which attains a broad array of significant applications that pose solutions to global issues and hold potential to facilitate worldwide change. Accordingly, the objective of this project is to propose a solution to widespread inaccessibility to treatments of a wide array of critical diseases using plants: mediums that are similarly universal. Millions depend on monoclonal antibodies for treatment of cancer and autoimmune diseases. However, an issue emerges with the accessibility of monoclonal antibodies, as the cloning process is costly and generates low yields. Many people do not have access to these life-saving treatments and therapies due to their high prices. This project uses molecular pharming, the transformation of plants to express proteins, specifically pharmaceuticals, within plant tissues. The aim of this project is to engineer plants to synthesize monoclonal antibody Rituximab, a life-saving therapeutic for the treatment of leukemia, non-Hodgkin lymphoma, and rheumatoid arthritis, in Nicotiana tabacum (common tobacco). The success of this project will provide an easy and costless production platform for monoclonal antibody therapeutics, which could benefit patients globally by providing accessible and effective treatments.

23. Travis Ray
Middle Tennessee State University
Faculty Mentor: Dr. Liz Barnes

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

Vaccines are a major scientific advancement, yet public mistrust persists. Undergraduate biology students already discuss vaccines with the public but often only discuss with those who share their views and use ineffective communication strategies (Couch et al., 2021; Bowen et al., 2023). Guided by the Theory of Planned Behavior (Ajzen, 2000), this study examines how students' attitudes, perceived difficulty, and social norms shape their vaccine-related conversations and how biology instruction influences their confidence. Using purposeful sampling, we recruited 30 undergraduate biology students across the nation to complete a survey about vaccine instruction and participate in semi-structured interviews. Interviews probed who students discuss vaccines with concerns about these conversations, and how their biology coursework prepares them. Quantitative survey responses were scored and averaged, and interview transcripts were analyzed using inductive and deductive content analysis with inter-rater reliability. Preliminary findings indicate students have positive attitudes towards vaccines and vaccine-related discussions but perceive conversations with "anti-vaccine" individuals as unproductive. Some students are confident despite misconceptions, while others with stronger knowledge lack confidence. Many students feel unprepared to counter misinformation and recommend curricular opportunities to practice vaccine communication. These data suggest biology curricula should better calibrate students' knowledge and provide structured communication practice.

24. Harlie Nehus
Tennessee Tech University
Faculty Mentor: Dr. Derek Cashman

Structure Prediction of MKK7/JNK3 Protein Using AlphaFold2-Multimer and Molecular Dynamic Simulation

c-Jun N-Terminal kinase 3 (JNK3) is a stress-activated kinase in neurons and activated in the MAP kinase signal transduction pathway by MKK4 or MKK7. It is involved in cellular injury, triggering apoptosis. The dysregulation of JNK3 is associated with the pathogenesis of neurodegenerative diseases – suppressing it limits triggers for the diseases which can be used as treatment. While the 3D structure of the JNK3 kinase domain is known, the structure of the 38-residue N-terminus (NJ38), believed to be important for binding MKK7, is unresolved due to its flexibility. In order to further understand the structural basis for the interaction of MKK7 with JNK3, five plausible stable complexes of MKK7/JNK3 were predicted using AlphaFold2-Multimer and simulated with NAMD v. 2.9. for 250 ns. Contacts were analyzed with the Protein Frustratometer and Evolutionary Trace methodologies to analyze new contacts formed between NJ38 and MKK7 and the JNK3 kinase domain. Molecular dynamic simulations were replicated for verification and higher confidence; results suggest proximity to the ATP-binding regions and the TPY motif of MKK7 and JNK3, and suggest novel structures for the active site of this complex.

25. Katelyn Hamilton
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Venkateswara Kode

Coffee-Derived Carbon Quantum Dots for Biofuel Enhancement: A Green Approach to Combustion Efficiency

Quantum dots (QDs) are nanoscale semiconductor crystals exhibiting unique optical and electronic properties, making them ideal candidates for various applications, including bioimaging, fluorescence, biosensing, and fuel efficiency. This project focuses on carbon quantum dots (CQDs). CQDs are valuable for fuel and ignition applications aimed at enhancing and altering combustion efficiency as well as energy release rates. CQDs face complications involving cost efficiency and sustainability during production, which is why the CQDs in this experiment will be derived from spent coffee grounds (SCGs). Coffee is a popular and widely consumed product with limited waste management. By altering SCGs, waste productivity for this highly demanded consumable can be improved, consequently refining resource management and sustainability in the coffee industry. Synthesis methods will involve pyrolysis, ultrasonication, surface functionalization, solvent interaction, and particle size differentiation for producing high-quality CQDs. Characterization methods include using a scanning electron microscope for topography observation, Fourier-transform Infrared spectroscopy for functionalization, and UV-visible spectroscopy for absorption analysis between 230-280 nm, as well as Cary Eclipse Fluorescence Spectrophotometry for excitation wavelengths around 360 nm. These methods will help enable sustainable synthesis of CQDs from waste biomass, ultimately supporting green chemistry principles for the betterment of the coffee and fuel industry.

26. Helen Tran
University of Memphis
Faculty Mentor: Dr. Rachel Diner

Evaluating the Antimicrobial Activity of Violacein Production in Janhthinobacterium Species

Janthinobacterium is a genus of gram-negative, rod-shaped bacteria commonly found in soil and freshwater ecological systems, also inhabiting the microbiomes of the animals within those systems. They exhibit various survivability traits, including the production of a purple pigment that possesses antimicrobial and antiviral properties called “violacein”, which possesses antimicrobial and antifungal properties. Three strains of *Janthinobacterium* isolates from freshwater clams in Memphis, TN, were plated in competition assays with co-isolated environmental bacteria to assess how the Janthinobacterium species would exhibit antimicrobial activity. The results of these assays showed signs of secondary metabolite production that was likely regulated by the bacteria’s quorum sensing, but no clear inhibition zones indicating antimicrobial activity. The results showed that all strains had a high susceptibility to chloramphenicol and gentamycin, but lower susceptibility to ampicillin, based on the patterns of the zones of inhibition produced. Moving forward, we will investigate the role temperature plays in pigment production and implications for microbial interactions. We will also investigate how these bacterial strains may defend host organisms against microbial pathogens.

27. Kelly Fitzpatrick
Austin Peay State University
Faculty Mentor: Professor Jane Semler

Evaluation of Factors Contributing to the Development of Urine Contamination Criteria

Contaminated urine specimens are a frequent issue in the clinical laboratory, and those coming from the emergency department are especially at risk because of the fast-paced environment. This can lead to unnecessary culture workup and inappropriate antimicrobial treatment. Oftentimes, contaminated urine specimens will produce a culture with either no growth or a mixed culture from normal flora. Urinalysis (UA) could be a good screening tool to detect potential contamination before a culture is set up, but criteria need to be established in order to make that distinction. The objective of this study is to evaluate urine specimens from the emergency department at Maury Regional Medical Center in Columbia, TN to determine potential factors that could be used to build contamination criteria and prevent unwarranted urine culture workups. Urinalysis results will be evaluated for the frequency of leukocyte esterase (LE), nitrite, white blood cell (WBC), bacteria, and epithelial cell (EC) results. The findings will aid patient care by fostering antibiotic stewardship and reduce waste by contributing towards protocols that would ensure contaminated urine does not reflex to a culture.

28. Aubreigh Morgan
East Tennessee State University
Faculty Mentor: Dr. Matthew Zahner

Histological Characterization of Descending Serotonergic Input to Sympathetic Preganglionic Neurons After Spinal Cord Injury

Spinal cord injury (SCI) disrupts descending pathways that regulate sympathetic preganglionic neurons (SPNs), the final central output controlling sympathetic baroreflex regulation of blood pressure. Loss of supraspinal input contributes to cardiovascular instability, including orthostatic hypotension that can limit participation in rehabilitation. However, the specific neural pathways involved and their organization within spinal sympathetic regions remain incompletely understood. Bulbospinal serotonergic (5-hydroxytryptamine, 5-HT) projections modulate spinal autonomic circuits, but their structural organization during early post-injury stages has not been fully characterized. The objective of this study is to examine descending serotonergic input to SPNs caudal to injury to identify pathway-level changes that may contribute to altered autonomic regulation. We hypothesize that SCI reduces serotonergic input below the lesion and that diminished descending modulation is associated with reduced sympathetic circuit activation. Adult rats received a left T7 hemisection and were studied one-week post-injury. SPNs were identified using choline acetyltransferase (ChAT) immunolabeling, and serotonergic input was visualized with 5-HT labeling. Sections were imaged using fluorescence microscopy. We will quantify 5-HT fiber density and ChAT positive neuronal expression on the left (lesioned) and right side of the spinal cord rostral and caudal to the lesion. This study will define pathway plasticity after SCI.

29. Olivia Vickers
Middle Tennessee State University
Faculty Mentor: Dr. Scott Handy

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

Natural products, like hypericin, have attracted interest as cost-effective, safer photocatalysts in organic synthesis. They effectively absorb light and offer an alternative to metal-based catalysts like ruthenium and iridium. Hypericin and its derivatives are naturally found in the supplement St. John's Wort, but isolating pure hypericin is difficult due to the low concentration. Although it is possible to bioengineer microorganisms to produce hypericin, the process is technically complex. Instead, we explored using St. John's Wort supplement capsules directly as the photocatalyst in arylation reactions, as well as ground St. John's Wort plant material. Additionally, the impact of various light sources, including lower-energy red light, will be investigated to assess how light wavelength and energy influence photocatalytic activity and reaction efficacy. To evaluate the efficacy of this approach, the recyclability of St. John's Wort will be tested using eco-friendly deep eutectic solvents and room-temperature ionic liquids. The results of this research should highlight the potential of natural product mixtures as effective, simple photocatalysts for organic reactions.

30. Krishi Patel
Tennessee Tech University
Faculty Mentor: Dr. Tania Datta

Evaluating the Water Demand and Energy Footprint of Artificial Intelligence Data Centers

The rapid expansion of Artificial Intelligence (AI) has accelerated the development of data centers, intensifying concerns about their substantial water and energy demands. As data centers continue to grow, meeting these resource requirements presents many environmental challenges. Moreover, resource consumption varies across data center types. This study synthesizes findings from peer-reviewed articles, technical reports, and publicly available datasets published between 2015 and 2025 to estimate the number and distribution of data centers in the United States, and their associated water and energy use. The review also evaluates the environmental implications of data center operations, including regional water stress, energy sourcing, and potential pollution impacts. Existing literature reveals substantial discrepancies in reported counts of U.S. data centers, reflecting inconsistent reporting practices. Nevertheless, on average, U.S. data centers consumed an estimated 66 billion liters of water in 2023 and approximately 200 TWh of electricity in 2022. Given the continued expansion of data centers, resource demands are projected to rise, emphasizing the need for the development of sustainable, alternative water and energy supply sources.

31. Sky High
University of Tennessee at Chattanooga
Faculty Mentor: Dr. David Giles

Pushing the Limits: Defining the Capacity for Vibrio Cholerae to Utilize Fatty Acids for Growth, Biofilm Formation and Membrane Phospholipid Remodeling

Vibrio cholerae is a Gram-negative bacterium found in freshwater and marine environments. Humans can become infected through ingestion of contaminated food or water, which can lead to an acute gastrointestinal infection known as cholera. Previous studies have indicated that the exposure of Gram-negative bacteria to exogenous polyunsaturated fatty acids (PUFAs) can impact the phospholipid membrane structure and integrity, along with other phenotypes such as growth, biofilm formation, and motility. Fatty acids can vary in carbon chain length and the location and number of double bonds. V. cholerae serves as a model organism for our study's goals due to its expanded repertoire of fatty acid handling machinery, including fatty acid cis-trans isomerase and multiple homologs for long-chain fatty acid transporters, CoA ligases, and acyltransferases. These proteins can alter the fatty chain elongation and trans-cis bond alteration. The purpose of this research is to observe how V. cholerae responds to a variety of exogenous fatty acids that range in carbon chain length (18-24) and level of unsaturation. There are three fatty acids with one degree of unsaturation, including 24:1 (15Z), 22:1 (13Z), and 20:1 (11Z), while the remaining seven fatty acids are polyunsaturated. Many conjugated fatty acids have demonstrated therapeutic effects in early clinical trials, including the ones chosen for this study, 18:2 (9Z, 11E) and 18:3 (8E, 10E, 12Z). Fatty acid 18:2 (9Z, 11E) is found in beef and milk fat, establishing cytotoxic properties to human cancer cells and antidiabetic outcomes. Fatty acid 18:3 (5Z, 9Z, 12Z) is found in pine seed oils and possesses lipid-lowering properties, playing a potential role in appetite suppression and in lowering LDL cholesterol levels. Fatty acid 18:3 (8E, 10E, 12Z) is derived from seed oils in marigold plants, substantiating a diverse array of anticancer properties in triple-negative breast cancer ferroptosis and leukemia apoptosis in mice. Fatty acid 20:2 (11Z, 14Z) is primarily found in animal tissues and is suggested to play a role in inflammatory processes by decreasing the production of nitric oxide and modifying macrophage response 16. Fatty acid 20:3 (11Z, 14Z, 17Z) is found in palm oil and certain nematodes and has effects on inhibiting fatty acid elongation and altering the conversion of fatty acids to eicosanoids. Fatty acid 22:4 (7Z, 10Z, 13Z, 16Z) is extensively found in the brain, adrenal glands, and kidneys and has a direct involvement in numerous pathophysiological processes, particularly through an increase in oxidative stress and inflammatory response. In this study, the fatty acids were evaluated for their effects i) on membrane permeability and biofilm formation using the hydrophobic dye crystal violet, ii) on utilization during normal growth and as sole carbon sources, and iii) on phospholipid profile alterations using a Bligh and Dyer phospholipid extraction in V. cholerae.

32. Holly Garcia
Austin Peay State University
Faculty Mentor: Dr. Leslie Hiatt

Beyond Expiration: GCMS Evaluation of Prescription Drugs

The stability of prescription medications following their printed expiration date remains an area of concern, with potential implications for patient safety, efficacy, and pharmaceutical waste. This study sought to examine whether measurable differences in prescription drug concentrations exist between recently dispensed and older prescription samples. Fluoxetine is one of the analyzed medicines and is a selective serotonin reuptake inhibitor (SSRI) that is widely prescribed for the treatment of mental and behavioral health conditions. Gas chromatography mass spectrometry (GC-MS) was employed as the primary analytical technique for detection and quantification. Method development included evaluation of different solvents and adjustment of instrument conditions to address challenges such as peak distortion and integration accuracy. Calibration was performed using standard solutions to enable comparison of sample concentrations. Preliminary findings indicated that concentration values for fluoxetine were comparable across the tested samples, with no clear evidence of significant degradation over time. However, variability between replicates suggested that refinements in sample preparation and analytical precision are needed to strengthen the reliability of results. These observations point to the potential for fluoxetine to retain chemical stability beyond expiration but highlight the importance of further research with additional prescription drugs and expanded testing conditions.

33. Morning Dove Rose
East Tennessee State University
Faculty Mentor: Dr. Cuihong Jia

Inhibition of Focal Adhesion Kinase Limits Axon Growth from Olfactory Sensory Neurons Following Injury

Olfactory sensory neurons (OSNs) regeneration in adult olfactory epithelium (OE) helps maintain sense of smell. New OSNs extend axons from the OE to the olfactory bulb via the lamina propria (LP). Adhesion inhibition restricts axon growth by blocking cell-substrate interaction, including integrin which signals through FAK. To determine FAK effects axon growth, we fate-traced Tdtomato (Tdt)+ axons in the LP in Mash1Cre-Tdtomato (Tdt) mice where Tdt protein was expressed in Mash1+ neuronal progenitor cells. We measured GAP43+ axons from new immature OSNs following injury into the LP. Mash1Cre-Tdt mice were treated with methimazole to deplete OSNs/initiate neuroregeneration. Three-Five days, we treated mice with saline or FAK inhibitor, FAK14, intranasally. 24h later, GAP43+ axons extended into the LP. Comparatively, FAK14 reduced GAP43+ area, suggesting FAK14 limits axon growth/extension, and reduced Tdt+ axons in the LP. Olfactory ensheathing cells (OECs) facilitate axon growth. Examining OECs contributive effects to FAK-14, we removed FAK in OECs of GFAPCre-FAKfl/fl mice and performed bulbectomy to deplete OSNs. Five days post-bulbectomy, GFAPCre-FAKfl/fl mice had less GAP43+ area in the LP than controls. Together suggesting that FAK promotes axon growth/extension through OECs. Thus, FAK signaling activation facilitates recovery of sense of smell following injury, virial infection or aging.

34. Madison Yahn
Middle Tennessee State University
Faculty Mentor: Dr. Elliot Altman

Bioinformatic Characterization of Mutations Associated with Enhanced Acetate Metabolism in Escherichia Coli

The conversion of lignocellulosic biomass into sugars that can be fermented into ethanol 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 utilize acetate as a carbon source to support acetate detoxification prior to yeast fermentation. Eight mutant strains were generated using spontaneous or EMS mutagenesis, then characterized using sequencing and analysis tools. Variant detection was performed using two pipelines. The mutants exhibited enhanced growth despite lacking mutations in acetate metabolism genes, rather changes occurred in genes associated with replication, acid resistance, metabolism, stability, and proton export. These mutations collectively improved stress tolerance, pH homeostasis, and efficiency. The results suggest that remodeling, rather than direct enzymatic modification, underlies enhanced acetate assimilation in E. coli, providing a foundation for designing robust microbial strains for bioethanol production.

35. Jackson Yerbich
Tennessee Tech University
Faculty Mentor: Professor Jane Semler

Desktop CNC

This project focuses on the design and development of a portable, low-cost desktop computer numerical control (CNC) machine. CNC technology is widely used in manufacturing to remove material from substrates such as wood, metal, and plastic with high precision. However, conventional CNC systems typically cost $5,000 or more, limiting accessibility for hobbyists, small businesses, and educational or home workshops. The goal of this project is to create a compact and affordable CNC platform that expands access to precision fabrication technologies for general users. The widespread adoption of consumer-grade 3D printers demonstrates how advanced manufacturing tools can transition from expensive industrial equipment to accessible household devices. This project applies similar principles of cost reduction, portability, and simplified fabrication to CNC systems. The proposed desktop CNC is designed to support small-scale production, prototyping, and custom fabrication tasks while maintaining essential machining capabilities. By lowering financial and technical barriers to entry, this work aims to broaden participation in digital manufacturing and support innovation, entrepreneurship, and hands-on engineering in home and small-business environments.

36. Jack Rawls
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Donald Reising

Optimizing Wireless Communication Pipelines with Neural Networks

The number of mobile users is projected to reach 9 billion by 2030, driven by the increasing demand for Internet of Things (IoT) devices. Modern communication systems must therefore be able to coexist with existing standards, operate at higher frequencies and higher data rates under adverse conditions. A crucial performance metric is the block error rate (BLER), which indicates a data transfer success or failure. Neural networks are being investigated as a promising solution because they thrive under increasing amounts of data, can be redesigned in short amounts of time and learn wireless channel distributions directly. This research assesses the performance advantages of replacing one or more of the Wireless-Fidelity (Wi-Fi) transmitter pipeline's blocks with a neural network. The goal is to improve BLER while maintaining low latency compared to traditional designs. Phase 1 investigates an ablative replacement of transmitter blocks, with the receiver pipeline unaltered, across signal-to-noise ratios (SNRs) of 2 dB to 23 dB in 3dB increments over 1,000 epochs per SNR. Future research will investigate altering the receiver pipeline while the transmitter remains unaltered and both pipelines jointly. This work provides potential means to implement 6G communications standards using neural networks.

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37. Desiraye McKeel
Austin Peay State University
Faculty Mentor: Dr. Professor Jane Semler

Variants of Unspecified Significance in Multi-Cancer Genetic Panels: Breast, Prostate, and Colon Cancers

Molecular diagnostics is the fastest growing area of disease detection and monitoring. Cancers result from the mutation of genes involved in the control of tumor growth, and can be somatic, or inherited. Inherited genetic mutations that are linked to cancer development account for 5% to 10% of all cancer diagnoses. Germline multi-cancer panels are designed to test gene loci known to produce pathogenic variants. Not all variations within a gene cause disease. "Variant of Unspecified Significance" (VUS) is the classification given to variants that are not known to be benign or pathogenic. This classification highlights the gene variants that are still undergoing research investigation, until there is enough evidence that supports the variant as benign or pathogenic. Results of this study could aid in determining which genes make efficient diagnostic tools. The aim of this study is to compare the rates of variation found between breast, colon, and prostate cancers, using Invitae germline multi-cancer panels. This comparison could highlight any correlation between VUS burden, cancer type, and location of recurrent variants.

38. Destiny Wilson
East Tennessee State University
Faculty Mentor: Dr. Sean Fox

Microbial Warfare: Alcaligenes as a Pathogen Predator

Microbes compete for the same limited nutrients, space, and resources; therefore, they show competitive relationships. Our laboratory has previously shown that Alcaligenes inhibits the growth of Staphylococcus, a Gram-positive bacterium, Bacillus, a Gram-positive bacilli and Candida, a fungus, which are all substantial causes of human infections. We are interested in determining the genetic factors in Alcaligenes that are responsible for killing these competitors. Transposon mutagenesis was used to interrupt gene segments by introducing a foreign piece of DNA into the Alcaligenes genome. By creating these mutants of Alcaligenes, we were able to screen these against Bacillus to find those that have increased lethal properties towards microbes. The increased zones of inhibition indicated that we successfully enhanced the genetic element in Alcaligenes that kills Bacillus. The genome of the mutant was isolated, and the area disrupted was sequenced. This mutant was tested with planktonic and biofilm experiments as well as testing antibiotic resistance. Results from this study may help us find new targets for Bacillus, Staphylococcus, and Candida infections.

39. Matthew Smith
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Azad Hossain

Using Satellite Imagery to Determine Water Quality

While there are already several satellites orbiting the earth dedicated to monitoring water quality, they have several major setbacks. Many water quality satellites have poor temporal resolution, and those that do not often have poor spatial resolution as a tradeoff. These water quality satellites also typically focus on the ocean or larger water bodies and by default lack the spatial resolution to monitor smaller bodies of water in any significant capacity. Instead of sending up a new satellite for the express purpose of monitoring rivers and smaller lakes, it's possible that data from imaging satellites like the Landsat missions can be used instead. By inserting the red band data from these satellites into a short equation, it is possible to obtain turbidity data for smaller water bodies with incredible accuracy as short as every nine days. Not only is this process simple, but it can be mostly automated with a small amount of code and easily visualized within ArcGIS Pro.

40. Neel Patel
Austin Peay State University
Faculty Mentor: Dr. Amy L. Thompson

The Paradoxical Effects of Coconut Oil and Tea Tree Oil on Fungus Malassezia furfur

Malassezia furfur is a lipophilic, commensal yeast that makes up the human skin microbiome and can become pathogenic causing conditions such as seborrheic dermatitis, pityriasis versicolor, and dandruff. While standard antifungal therapies like ketoconazole continue to be effective, concerns about antifungal resistance, recurrence, and adverse effects necessitate research in natural alternatives, including plant oils. The current study looked at how tea tree oil and coconut oil impacted M. furfur growth and development. The fungus was grown on potato dextrose agar enriched with olive oil to provide adequate lipids. Plates were incubated at 32°C with 70% humidity. Over a 15-day period, experimental sets were treated with sprays of tea tree oil or coconut oil and compared to untreated control plates. Macroscopic inspection and microscopic staining using lactophenol cotton blue showed that tea tree oil inhibited M. furfur development over the 15-day incubation period. While coconut oil seemed to delay initial development, it ultimately failed to limit long-term proliferation, showing increased fungal growth at later timepoints. These results demonstrate that tea tree oil is an effective long-term antifungal agent against M. furfur, but coconut oil, despite being considered good for skin conditions, may actually promote fungal growth.

41. Jack Womack
East Tennessee State University
Faculty Mentor: Dr. Manik Ahuja

Risk and Protective Factors to Hyperlipidemia in Rural North Carolina, Tennessee, and Virginia

This study analyzes risk and protective factors for hyperlipidemia in rural North Carolina, Tennessee, and Virginia. Hyperlipidemia is a risk factor for stroke and cardiovascular disease (CVD), two leading causes of death in the United States that have an increased mortality gap in the rural Southern US. Using cross-sectional data from a nationally representative telephone-based survey of US adults, responses were extracted from North Carolina, Tennessee, and Virginia (n=17,236), and logistic regression analyses were conducted to test the association between depression, physical activity, smoking, alcohol use, and high cholesterol (outcome). The model controlled for income, race, educational level, health insurance status, and age. Results revealed that participants from rural areas reported that depression (OR =1.47, 95% CI, 1.19, 1.81), and no past month exercise (OR=1.44, 95% CI, 1.21,1.76) were associated with high cholesterol. In urban areas, low income, less than high school education, male gender, depression, and no past month exercise were associated with high cholesterol. These findings reveal that risk factors for hyperlipidemia are distinct between rural and urban areas and are influenced by various social and behavioral determinants. While more comprehensive research is still needed, this study can help inform regional public health responses.

42. Samuel Smith
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Jannatul Ferdoush

Unveiling Key Hub Genes in Odor-Related Transcription Factors and Cancer to Identify Potential Therapeutic Strategies

Cancer remains a leading cause of death worldwide, and identifying new molecular regulators is essential for developing therapies. Recent studies show that odorant receptors and their associated transcription factors (ORTFs), typically linked to smell, are also expressed in various cancers. However, their roles in tumor development are not well understood. In this study, we analyzed seven contemporary GEO datasets containing paired tumor and normal samples from head/neck, lung, and breast cancers. Using GEO2R and volcano plot analysis (|log2FC| > 1.5, p < 0.05), we identified differentially expressed ORTF-related genes (DEG). Venn diagram comparisons revealed two shared genes across breast cancer datasets. We further used gene ontology (GO:1905515 – non-motile cilium assembly) to find 60 ORTF-related DEGs across all three cancer types. We aim to build protein–protein interaction (PPI) networks to identify hub/biomarker genes and assess their therapeutic potential through molecular docking. This integrative approach sheds light on the role of ORTFs in cancer and their potential as drug targets.

43. Calleway Schmidt
Austin Peay State University
Faculty Mentor: Bohdan Mahlovanyi, Dr. Roman Golovchak, Dr. Andriy Kovalskiy

Glassy Materials Fighting Pathogens in Public Environments

One of the biggest challenges for modern society is related to the transmission of diseases and infections through high touch points in public places like hospitals, schools, gyms, and public offices. As the COVID-19 pandemic showed, it can have a tremendous impact on global health and economy. Many patients in hospitals also suffer because of the bacteria growth on the interface between various medical equipment and body fluids while in contact for longer periods. To prevent the infection from spreading, materials that can inhibit bacteria growth or have bactericidal effects are needed. They should be durable, inexpensive and safe for body fluids or blood cells if used in vivo. Up to date, the most convenient materials for medical equipment, products, and high touch point articles are glasses, their derivatives, or amorphous coatings. In this work, twelve glasses of (P2O5) −(Fe2O3/SrO/SiO2) − (CuO/ZnO) compositions were synthesized and tested against Staphylococcus aureus. Results indicated that samples with SiO2 and B2O3 where the least effective while the most effective samples contained Zn and Cu, two being a mixture of both. These glass compositions can be used as inhibitors for bacteria growth.

44. Emily Wood
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Jannatul Ferdoush

Farnesoid X Receptor (FXR) Agonists and Protein Kinase Regulation in NAFLD and NASH: Mechanisms and Therapeutic Potential

Non-alcoholic fatty liver disease (NAFLD) is a common metabolic condition characterized by hepatic lipid deposits, insulin resistance, and inflammation which may progress to non-alcoholic steatohepatitis (NASH) and fibrosis. Protein kinases play an important role in NAFLD development by regulating metabolic and inflammatory pathways. Mitogen-activated protein kinases (MAPKs), protein kinase C (PKC), AMP-activated protein kinase (AMPK), phosphoinositide 3-kinase (PI3K)/AKT, and mechanistic target of rapamycin (mTOR) are all involved in NAFLD and NASH progression. Emerging evidence indicates that Farnesoid X Receptor (FXR) agonists have therapeutic potential by modulating bile acid metabolism, lipid balance, and inflammatory responses. This review examines the mechanistic interplay between FXR agonists and important protein kinases in NAFLD and NASH. FXR agonists activate AMPK, which promotes fatty acid oxidation and reduces hepatic steatosis. They also regulate MAPK signaling, which reduces c-Jun NH2-terminal kinase (JNK)- and p38 MAPK-mediated inflammation. Furthermore, FXR agonists activate the PI3K/AKT pathway, enhancing insulin sensitivity and modulating mTOR signaling to reduce hepatic fibrosis. Clinical studies in NAFLD/NASH indicate that FXR agonists confer metabolic and anti-inflammatory benefits, although optimizing efficacy and minimizing adverse effects remain challenging. Future studies should focus on combination therapies targeting FXR alongside specific kinases to improve therapeutic outcomes. This review highlights the potential of FXR agonists to modulate protein kinase signaling, opening new avenues for targeted NAFLD/NASH therapy.

45. Keira Scott
Austin Peay State University
Faculty Mentor: Dr. Emmabeth Parrish-Vaughn

Photochrome Polymers for Advanced Photonic Applications

Dihydroazulene photochromes demonstrate high sensitivity and temporal-spatial resolution, rendering them promising for applications in solar energy harvesting and information storage systems. Compared to most photochromic materials, Dihydroazulene-based compounds exhibit pronounced differences in absorption maxima between their two isomers, which are interconverted by external stimuli such as light and heat. In this work, Dihydroazulene molecules were embedded into nine distinct photo-inert polymers. The kinetics of optical transmission changes under UV irradiation were recorded in air using a fiber-optics spectrometer within 400-900 nm optical range. The kinetics exhibit a logarithmic time-dependence for absorbance at short times, with a maximum rate of change at 480–500 nm on a semi-logarithmic scale. At wavelengths above 530nm, optical absorbance diverges from this dependence during prolonged exposure. The slope of the linear region of this dependence increases slightly as the polarity and conjugation of the polymers decrease. The observed changes could be recovered by temperature annealing. The recovery kinetics measured at 90 °C and 100 °C are well described by a stretch-exponential function. The kinetic characteristics showed only minor sensitivity to the specific nature of the host polymer, supporting the use of Dihydroazulene molecules as photochrome agents in industrially important polymer matrices for photonic devices.

46. Olivia Ziemer
University of Tennessee at Chattanooga
Faculty Mentor: Dr. Luis Sanchez Diaz

Short-Term Plasticity Characterization in Droplet Interface Bilayers is Impacted by the Oil Environment

Devices which demonstrate resistance, capacitance, or inductance capabilities depending on their past electrical activity are known as memory elements. Memory elements can be observed in lipid bilayers through different experimental techniques in which voltage is applied across the lipid bilayer, and current response can be measured. The result of previous experimentation demonstrates that lipid bilayers store energy in a similar fashion to a capacitor as they maintain current for a period of time even after voltage stimulation ends. Droplet Interface Bilayer (DIB) experiments can be used to isolate and investigate variations in the oil composition of a synthetic membrane's environment to determine the alkane ratio which most greatly enhances membrane stability and gramicidin facilitated ion transport. Such experiments will aid in the development of a thorough understanding of the capacitive and other various electrical properties of lipid bilayers and how variations in the molecular environment change those properties.

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