Posters at the Capitol

Hosted by Tennessee STEM Education Center, MTSU

Undergraduate Student Research

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

April 2, 2025

Posters at the Capitol 2025

Cordell Hull Building
425 5th Avenue
Nashville, Tennessee 37243

On February 1, 2006, Tennessee joined a dozen other states by exposing state legislators to undergraduate research from across the state through the first-ever Tennessee Posters at the Capitol. Fifty-seven undergraduate students from eight public universities will present their research through posters at the Tennessee State Capitol in Nashville. Legislators will be encouraged to meet students from their districts and see first-hand the outstanding research being conducted by undergraduates across the state. The Posters at the Capitol project, hosted by Middle Tennessee State University, has two goals—to expose legislators to undergraduate researchers and to expose undergraduates to their legislators. The state of Tennessee is the beneficiary of this exciting effort.

Participating Universities

Austin Peay State University (APSU), Dr. Michael Licari, President
East Tennessee State University (ETSU), Dr. Brian E. Noland, President
Middle Tennessee State University (MTSU), Dr. Sidney A. McPhee, President
Tennessee State University (TSU), Mr. Dwayne Tucker, President
Tennessee Technological University (TTU), Dr. Philip B. Oldham, President
The University of Tennessee at Chattanooga (UTC), Dr. Robert Dooley, Interim Chancellor
The University of Tennessee, Knoxville (UTK), Dr. Donde Plowman, Chancellor
The University of Tennessee at Martin (UTM), Dr. Yancy Freeman, Chancellor
The University of Memphis (U of M), Dr. Bill Hardgrave, President

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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 excited to showcase some of the amazing research conducted by our bright and creative students. Their work is at the heart of what we do as an institution, with the University offering several opportunities through its Centers of Excellence in both creative arts and field biology, our new Institute for National Security and Military Studies and in most classrooms, regardless of the subject matter. We want our Governors to stretch their thinking beyond our campus borders, and during this Posters at the Capitol event, you'll see some of the exciting work they've produced. They achieved this success by working closely with our renowned faculty – leaders in their own respective fields. The APSU Office of Student Research and Innovation (OSRI) also helps foster our students' endeavors, encouraging them through mentorship, funding, and helping find valuable collaborators. It's easy to see the potential in our students, and we're investing in them because we know their work will help transform 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 State University

Dwayne Tucker, President

It is my pleasure to welcome you to the Posters at the Capitol event. Undergraduate research is an integral component of students' educational experience at Tennessee State University. Engaging students in the process of science assures the achievement of the highest level of learning. The posters on display by our undergraduate students represent the larger body of research work performed by STEM students across the University.

The research illustrated by the posters presented at this gathering could not have been produced without a dedicated faculty who devote an extraordinary amount of time to the research enterprise and to serving as research mentors for students. Again, welcome and thank you for your continuous support of Tennessee State University.

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 University of Tennessee, Knoxville

Donde Plowman, Chancellor

Congratulations to all the students presenting at Posters at the Capitol 2025, along with the faculty members and other mentors who have supported their work. As the state's flagship land-grant research university, the University of Tennessee, Knoxville, is committed to discoveries that solve challenges and drive economic impact for our state. Students who participate in research at UT engage in the highest level of discovery, advancing knowledge while supporting their own academic goals and careers.

Undergraduate research is an important part of our mission of education, discovery, and service. Last year 1,165 students presented their research at our two signature annual symposia: Discovery Day and the Exhibition of Undergraduate Research and Creative Achievement.

In addition to fostering the mentored research that happens within departments and across colleges, UT is focused on removing barriers and creating more opportunities for students through the Departmental Research Assistantship Program, which offers paid research opportunities for Pell-eligible and first-generation college students. Partnerships with organizations like Oak Ridge National Laboratory, the Tennessee Valley Authority, and the Tennessee Department of Environment and Conservation expand and enhance the opportunities available for students to develop real-world skills alongside experts in multiple fields.

Research is imperative to undergraduate education. It helps students connect more fully with what they learn in the classroom, the laboratory, the studio, and the field. It prepares them for the workforce, graduate school, and future endeavors by helping them build strong mentoring relationships and skills in teamwork, cultural competency, and critical thinking.

At UT, we are proud of our exemplary researchers, scholars, teachers, and innovators. We are excited for our students to share their undergraduate research projects at this important event.

Go Vols!

Donde Plowman

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.

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Poster Abstracts

1. Nima Aflaki
The University of Memphis
Faculty Mentor: Dr. Timothy Brewster

Mechanistic Investigation of Substrate Docking in a Traceless Tether Catalyst

Our lab has designed a novel, regioselective dock and release system for C-H functionalization, aimed at producing poly-substituted aromatics more efficiently. We believed that our dock and release system can be made possible by using a traceless tether based on triazolopyridine (tripy) which provided stability and the correct geometric alignment for substrates to collide and react. We synthesized our reactants and combined it with the tripy, water, and a proton donor to test for C-H activation was possible. We conducted this reaction in different conditions of water concentration, temperature, with different tripy variants, and with and without palladium. By using a Flourine-19 NMR we were able to determine the concentrations of our reactants and products at different times during the reaction and find the equilibrium and kinetic properties of our dock and release system. The results indicated that the reaction was proceeding successfully with sufficient yields without the metal, however failing whenever we added the metal because the tripy was not stable enough. These results successfully demonstrate our dock and release mechanism for regioselective C-H activation which has the potential for transforming effects on the production of poly-substituted aromatics.

2. Ellie Bray
Tennessee State University
Faculty Mentor: Dr. Margaret Whalen

The Role of MyD88 in Pentachlorophenol Stimulation of Interleukin-1β Production by Human Immune Cells

Interleukin-1β (IL-1β) is a proinflammatory cytokine produced in response to injury or infection. High levels of IL-1β, in the absence of infection or injury, can lead to chronic inflammation which is linked to increased pathologies including cancer. Pentachlorophenol (PCP) is an environmental contaminant detected in human blood at levels as high as 5μM and is associated with respiratory diseases and cancer. Previous studies indicate that PCP stimulates the production of IL-1β by immune cells and that this production involves toll-like receptors (TLR), which are linked to the intracellular adapter protein MyD88. Based on this information, we hypothesize that blocking MyD88 function will greatly diminish the ability of PCP to stimulate IL-1β production by immune cells. Cells were treated with a selective inhibitor of MyD88 and tested for PCP stimulation of IL-1β production using ELISA and western blot. Results show that MyD88 is needed for PCP-induced increases in IL-1β and clarify the mechanism by which PCP could lead to chronic inflammation and the diseases associated with it.

3. Grace Holt & Joyce Daaga
Austin Peay State University
Faculty Mentor: Dr. Jackie Vogel


What factors impact student learning with students who exhibit math anxiety?

Mathematics anxiety can impact students in many negative ways as they progress through school and into their careers. The researchers investigating the impacts of mathematics anxiety, Grace Holt and Joyce Daaga, are part of the Partners Engaged with Emerging Researchers (PEER) Program. This Program is a research collaboration between Middle College High School students and their university faculty mentor. The high school undergraduate researchers are conducting literature reviews and interviews to deepen their understanding of mathematics anxiety. Preliminary results indicate that teacher expectations, teacher anxiety, and gender impact the students' potential for mathematics anxiety. This research project is ongoing and is expected to illuminate additional factors impacting students' potential for mathematics anxiety and its associated impact on student learning.

4. Izzy Jacober
Middle Tennessee State University
Faculty Mentor: Dr. Tiffany Rogers

The Differing Effects of Oxytocin on Maternal Motivation in Mice

Levels of social interaction are often decreased in those with autism spectrum disorder (ASD). The social motivation hypothesis of ASD suggests that this stems from lower motivation toward social interaction, which is a product of alterations in the dopaminergic reward system. One proposed treatment for the decreased social drive seen in ASD is oxytocin. Oxytocin is a neurotransmitter and hormone commonly linked to social behaviors and plays an important role in the development and maintenance of relationships. Paradoxically, the pattern that has emerged from research in the Rogers Lab is that administering oxytocin to mice decreases levels of social interaction. This experiment will further investigate this phenomenon, specifically examining oxytocin's role in mediating maternal motivation by separating mouse mothers (dams) from one of their pups by an obstacle. Previous findings from the Rogers Lab suggest that oxytocin will increase maternal motivation when effort is low, and decrease maternal motivation when effort is high.

5. Sara Batts
The University of Tennessee at Martin
Faculty Mentor: Dr. Ann Gathers & Dr. Saman Sargolzaei

Mental Imagery & Selective Attentional Control: An Investigation into Their Connection Using EEG

Since the late 19th century, the role of mental imagery in consciousness has fascinated researchers, and in recent decades, neuropsychological studies have explored its links to cognitive abilities like memory and focus. Recent studies suggest a positive relationship between the ability to generate vivid mental imagery and attentional control, with neuroimaging techniques revealing associated brain activity patterns. In the present study, we aim to explore the relationship between mental imagery and selective attentional control using electroencephalography (EEG). We hypothesize that individuals with stronger mental imagery generation abilities will exhibit enhanced selective attentional control. Conversely, individuals with less vivid mental imagery abilities may show lower levels of attentional control. At the EEG level, we expect that individuals with stronger mental imagery abilities will demonstrate increased or higher-quality beta and theta wave activity compared to those with weaker imagery generation skills. This study aims to deepen our understanding of how mental imagery influence cognitive performance, with potential implications for academic and work environments.

6. Laura Gilliard
The University of Tennessee, Knoxville
Faculty Mentor: Dr. Joe Smith

Investigation of Goat Metabolization of the Deworming Medication 'Levamisole'

Resistance to deworming medication for gastrointestinal worms is a growing animal health concern among livestock producers, especially goat producers. This study aimed to characterize goat metabolization of a deworming medication called Levamisole. Although approved for use in cattle, Levamisole can be used off-label to treat goats, but the metabolization and movement throughout the body of Levamisole in goats is unknown. Six goats were used in this study, and oral doses of Levamisole were administered by a veterinarian. Blood samples were collected afterward for laboratory analysis. Analytical chemistry and statistical analysis were used to determine how goats metabolize the drug Levamisole, and values such as maximum drug concentration and drug elimination half-life in the goats' bloodstream were determined. This data provides a foundation for comparing the metabolization of Levamisole and determining the bioavailability of other Levamisole formulations intended for use in goats.

7. Adriel Poo Armas
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Eric Hoang Nguyen

Automatic Annotation for YOLOv10 using SAMv2 Segmentation Model

During my time as a Research Assistant for the Center of Urban Information and progress of UTC (CUIP) I have had the privilege to work on diverse projects. Between them an approach to automate annotations of scooter videos -captured by The Smart Cities tested at Martin Luther King- using the SAMv2 model and subsequently train a YOLOv10 model for object detection. We detail a multi-step architecture, beginning with video preprocessing: extracting frames and preparing them through normalization and optional data augmentation. The SAMv2 model is then utilized to segment scooters within frames, generating segmentation masks, which are converted into bounding box annotations. These annotations are formatted for YOLOv10 training. Then post-processing follows which includes annotation refinement and dataset organization. The YOLOv10 model is trained using optimized hyperparameters to detect scooters in real-time. This project showcases efficient large-scale data labeling, reducing manual intervention, and provides a scalable solution for scooter detection in urban environments.

8. Gracey Cobble
Tennessee Tech University
Faculty Mentor: Dr. Craig Henderson

Lab Scale Verification Testing of Smart Building Sensors

At the time this study was conducted, Tennessee Technological University was in the process of constructing the Ashraf Islam Engineering building (AIEB). The AIEB itself is a 3-story, 100,000 square-foot building with a lateral force resisting system (LFRS) comprised of moment frames. These moment frames are designed to resist the horizontal forces (e.g., winds and earthquakes) applied to the structure.

The AIEB facility is a vibration-based Smart Building containing sensors (e.g., strain gauges, accelerometers, and ground accelerometers) placed throughout the structure by faculty and students in Tennessee Tech's Civil and Mechanical Engineering Departments. The Smart Building is intended to be used as an "instrument" by practicing engineers and engineering students for the conduction of research related to vibrations, Building Information Modeling (BIM), and structural behavior.

The strain gauges and accelerometers were placed as close to the moment connections (i.e., the beam to column juncture) of the frames as possible to measure worst case building stresses. Research was conducted in order to verify the ability of the data acquisition system (DAQ) to retrieve the data from the attached instrumentation. These DAQs were placed in each of the six data rooms that are located throughout the building. The purpose of this research was to verify the connectivity of the DAQs, sensors, and cabling in the AIEB by evaluating three small-scale test configurations. These tests included a pendulum column, a 3-story small-scale structure, and a static beam. The results from these tests were verified with theoretical calculations.

9. Michelle Lee
The University of Memphis
Faculty Mentor: Dr. Jessica Amber Jennings

Inflammatory Response of Contaminated Burn Wounds Treated with Electrospun Chitosan Membranes Loaded with Biofilm Inhibitors and Bupivacaine

Burn injuries activate a robust inflammatory response, which is crucial for tissue repair but may cause adverse effects, such as prolonged healing, if not properly managed. Local anesthetic bupivacaine (BUP) and biofilm inhibitor cis-2-decenoic acid (C2DA) released from electrospun chitosan membranes (ESCM) have been shown to affect inflammatory responses in vitro. In this study, we evaluated inflammatory response in a murine model of contaminated burn healing.We hypothesized that the inflammatory response, as determined by depth of basophilia, would be minimized using ESCM loaded with BUP and/or C2DA compared to gauze and commercial standard of care controls, Silverlon dressing and silver sulfadiazine cream. We used a brass comb scald model with *P. aeruginosa* (10^3 CFUs) inoculation in Wistar rats to model contaminated burn wounds. BIOQUANT image analysis software was used for imaging histological slides. Histological evaluation of burn depth at 3 days post burn showed infiltration of immune cells, i.e., neutrophils, extending until the deep dermis layers for all animals. Results suggest that the dressings were able to prevent the damage from spreading to the healthy tissue at the zones of stasis/interspaces. While not statistically significant, the ESCM+Combo group appeared to minimize the inflammatory response of the burn wound.

10. J. Alyx Cotton
Tennessee State University
Faculty Mentor: Dr. Tom Byl

Harmful Algal Bloom monitoring in the Tennessee State University Wetland

The wetland on Tennessee State University (TSU) research farm provides a significant amount of ecological services, such as removing sediments and nutrients from the stormwater before it enters the Cumberland River. The result of sequestering nutrients has led to eutrophication of the wetland. The waters can change from clear to covered in phytoplankton and duckweed in 24 hours. Sometimes the phytoplankton community is dominated by cyanobacteria (bluegreen algae) that can produce toxins, such as microcystin and anatoxin. These are liver and neurotoxins, respectively. A monitoring program collecting water samples every 2 weeks has been in place from 2022 through 2024. Microcystin concentrations ranged from below detection (0.15 ug/L) to above 5 ug/L. Additional water chemistry data is being monitored to determine what precedes the production and release of microcystin in this wetland system. A better understand will protect the livestock and wildlife that use this habitat.

11. Tatiana Prieto Duanah & Julia Martins
Austin Peay State University
Faculty Mentor: Dr. Ramanjit K. Sahi


Raising Awareness about Addiction and its Effects on College Students

Inspired by personal experiences with addiction in our families and a deep interest in psychology, we are determined to address the impact of addiction on families and communities. As Middle College students earning both high school and college credits, we are honored to work with Dr. Sahi through the Partners Engaged with Emerging Researchers program and the College of STEM at Austin Peay State University. Our project focuses on raising awareness about addiction's effects on college students, highlighting the academic struggles faced by those impacted, and organizing fundraisers to support drug-free initiatives on campus. Our research explores addiction-related behaviors, their underlying causes, and strategies to prevent unhealthy drug use among students. By fostering understanding, we aim to promote a healthier campus environment where students can thrive without the burden of addiction.

12. Edwin Walck
Middle Tennessee State University
Faculty Mentors: Dr. Jeremy Aber

Natural and Anthropogenic Ecosystem Loss Following Establishment of Percy Priest Lake

Worldwide, the construction of dams has provided large-scale hydroelectric power and flood control but is also responsible for extensive environmental disruption. One example was the damming of the Stones River in middle Tennessee in 1967, which produced the 5,747-hectare Percy Priest Lake. The objective of this study was to evaluate the extent of natural and anthropogenic ecosystems lost due to the formation of this lake. Using pre-lake aerial photographs, ecosystems that were covered by the lake were identified, mapped, and their area quantified using ArcGIS. The largest ecosystem lost was non-forested areas, which were mostly crop lands in the Stones River floodplain, and woodlands were the next highest ecosystem lost. Forests, the Stones River and its tributaries, and cedar glades represented <13% of area lost. In addition, at least 188 structures and four bridges were destroyed. The damming of Stones River represented an economic loss to farmers, which included their agricultural land and buildings, and a loss in important natural ecosystems, such as cedar glades and riverine environments. Similar losses likely occurred throughout the southeastern United States in the 20th Century as the Tennessee Valley Authority built many dams in the region.

13. Calixte Neveah Walls
The University of Tennessee, Knoxville
Faculty Mentor: Dr. Rajan Lamichhane

Investigating the Effect of Opioid Drugs on Their Target

Opioid drugs, including painkillers, work by attaching to a special protein in our body called the mu-opioid receptor (MOR). This receptor sits in cell membranes and acts like a switch that can help to turn pain signals on or off. It is organized as a bundle of ribbons held together by turns within the cell membrane, with disordered tails extending from either side of the membrane that bind small molecules and proteins. The shape of this receptor is flexible, which means that after opioids binding, the receptor changes its shape. That change is directly related to either pain relief or causes several unwanted side effects, including addiction, tolerance, and breathing problems. This study aims to investigate how different opioid drugs affect the shape and flexibility of MOR. To test this, we used a modified, water-soluble version of the human MOR that makes it easier to study. We purified the receptor and tested its change in shape in response to temperature and binding of different opioid drugs, like DAMGO and BMS-986122. Additionally, advanced imaging techniques like single-molecule Förster Resonance Energy Transfer (smFRET) helped to see these changes one molecule at a time. Our results indicate that the tested drugs make the receptor more stable. These findings could help develop better pain drugs by looking at how drugs interact with the receptor and change its flexibility – leading to safer and more effective treatments.

14. Matthew Boone
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Tatiana Allen

A LEGO Based Low-Cost Autonomous Scientist: Using Machine Learning to Derive the Henderson-Hasselbalch Equation

The University of Tennessee-Chattanooga chapter of the Society of Physics Students (SPS) has constructed a LEGO-based, low-cost autonomous scientist (LEGOLAS). It is a robot built upon a cartesian gantry that uses machine learning techniques to autonomously derive the Henderson-Hasselbalch equation. LEGOLAS accomplishes this by via autonomous titration experiments, which reduces the tedious steps involved in typical acid-base experiments. Originally, it was developed in collaboration between NIST and UMD scientists as a teaching tool to introduce students to machine learning techniques and algorithms. This project was our 2024 Research Project and was funded by the SPS National Chapter Research Award. While working on this project, we learned about 3D printing, Raspberry Pi computers, Arduino computers, pH sensors, Bayesian statistics, Gaussian processes, and other topics that are not usually taught in undergraduate curriculum. We plan to use this model to introduce students to machine learning, to develop other autonomous experiments, and for departmental recruitment and outreach.

15. Alexandra DeBruyn
Tennessee Tech University
Faculty Mentor: Dr. Daniel VandenBerge

Fiber Optic Instrumentation of Demonstration Beams

Tactile devices and demonstrations provide engineering students with tangible ways to connect abstract concepts to experiential knowledge. This project used high density fiber optic sensing (HDFOS) technology to measure strain in 1) a thermally expanding beam and 2) an artificially damaged beam. The sensing allowed strain to be measured in a distributed manner along the length of the beams. The objectives and constraints for the structures were determined at the beginning of the project. Detailed instructions for the use of the beams to demonstrate thermally-induced strain and stress concentrations were generated.

16. Elisabeth Denis
East Tennessee State University
Faculty Mentor: Dr. Eric W. Sellers

Effects of Childhood Adversity on Brainwave Activity in Assessing Facial Expression

The lifespan effects of adverse childhood experiences (ACEs) on individual psychosocial cognition and behavioral health outcomes have become a topic of public interest. A rising awareness of mental health issues has highlighted diverse effects of early trauma. While much of the research has focused on subjective measures of mental well-being, there is growing interest in the impact of childhood trauma on physiological brain function. Previous event related potential (ERP) research has been inconclusive as to the relationship between ACEs and brainwaves; some studies have shown higher amplitude responses to emotional facial expression compared to neutral facial stimuli, while others have found the opposite result. The goal of the current study is to elucidate the physiological effects that underpin social cognitive dysfunction in individuals who have experienced childhood adversity. Using electroencephalogram (EEG), the face-sensitive N170 ERP can be used to examine difference in how the brain responds to facial expressions. Participants completed the Variability in Adverse Childhood Experiences (VACE) scale. Participants were connected to EEG and completed a canonical oddball task requiring them to differentiate between negative, positive and neutral facial expressions. Significant correlation between VACE score and N170 amplitude in the right hemisphere was observed.

17. Elizabeth Matlock-Buchanan
The University of Memphis
Faculty Mentor: Dr. Jessica Amber Jennings

Tosh Farms Sow Lameness Prevention Project: Using Biomedical Approaches in an Agricultural Setting for Intervention in Culling of Sows due to Lameness

In the swine industry, sow lameness can be an important cause of economic loss for pig producers. Lame sows are typically euthanized resulting in loss of sow and current/future progeny. A primary cause of lameness is infection in cracked and overgrown skin on the hooves, which can lead to osteoarthritis, lesions, and osteochondrosis, among other ailments. Standard of care treatment of foot lesions depends on early recognition and aggressive antibiotic medication before deep-seated abscessation has occurred. Hydrogels and chitosan silver composites have demonstrated efficacy in preventing infection-causing biofilm formation and can form a barrier on the skin, making these composites potentially beneficial as wound treatments. The use of silver-loaded hydrogels has multiple advantages over the standard of care treatment in that gels do not require reapplication for several days, do not contain traditional antibiotics that promote antimicrobial resistance, and form a barrier to support moist wound healing and while preventing further contamination. The purpose of this study is to obtain preliminary data on the utility of hydrogel materials with and without antimicrobials in treatment of lesions in sows. We will follow a small cohort of sows and perform assessments of treated sows.

18. Jai Lin Salas
Tennessee State University
Faculty Mentor: Dr. Tom Byl

Tree Survey of Urban Trees near a Wetland Scheduled for Restoration

Tennessee State University (TSU), College of Agriculture received a $4-million dollar grant to restore the wetland on the TSU research farm in Nashville, TN. The grant was sponsored by the US Dept of Agriculture – Forest Service. One of the goals was to replace invasive trees with native trees so that the natural area would provide better habitat for wildlife and continue to provide eco-services to the TSU community. In order to document the restoration benefits, this project engaged in quantifying the invasive tree occurrence and distribution prior to restoration. The 40 acre wetland is surrounded by a variety of trees so a transect method was used since it is impractical to count every tree, bush and vine. Older tree stands around the wetland tended to be more invasive species. Whereas the newer tree stands had a higher Shannon Diversity Index. These preliminary results indicate that urban forest restoration of the wetland should succeed once the invasive species are replaced with native species.

19. Quinn Schneider
Austin Peay State University
Faculty Mentor: Dr. Mary Akinyemi

Examining Stock Indices Through the Monocles of Country Partnerships

Mathematics and analysis have always, in one way or the other, played and still play a key role in decision-making. Various industries lean on mathematical models and analysis based on those models to understand industry trends. Over the past couple of months, Dr. Akinyemi and I have been using statistical analysis to explore relationships between the United States stock index, specifically the S&P 500 and stock indices from Mexico (ARCA), and Canada (CCIER). By examining these relationships, we can potentially shed more light on how market dynamics in allied countries can affect the prices of top gainers in a country's stock market.

20. Rashieq Cockerham
Middle Tennessee State University
Faculty Mentor: Dr. Paul Kline

Characteristics of the Structure and Selected Biological Activities of Polysaccharides Isolated from Hemp

Hemp (Cannabis sativa L.), an industrially significant crop, holds vast potential for various applications due to its rich composition of bioactive compounds, including polysaccharides. This research aims to characterize the structural properties and explore the biological activities of polysaccharides isolated from hemp. By investigating these compounds, we seek to uncover their potential applications in industries such as pharmaceuticals and biotechnology, with a focus on their antioxidant, anti-inflammatory, and immunomodulatory properties. The study employs techniques such as gas chromatography, mass spectrometry, and NMR spectroscopy to analyze the molecular composition and linkage patterns of hemp-derived polysaccharides. Through these methods, we aim to bridge existing knowledge gaps and optimize extraction processes for the efficient utilization of these bioactive molecules. Ultimately, this research will contribute to the growing understanding of hemp polysaccharides and their potential to enhance both scientific and industrial applications.

21. Lydia Honbarger
The University of Tennessee at Martin
Faculty Mentor: Dr. Stan Dunagan

Assessing the risk of nitrate contamination in the surface waters of the Mississippi River and its tributaries, 1980-2010

Heightened nitrate levels in surface water pose several risks to human health and development. A study sampling key locations along the Mississippi river and its tributaries from 1980 to 2010 tracked nitrate contamination over time. This is important in that the Mississippi watershed drains approximately 40% of the continental U.S., while the river serves as the primary drinking water source for over 20 million Americans. Major contributors to nitrate pollution include corn-based agriculture, soil type, and regional precipitation. These factors impact the risk of nitrate accumulation in watershed regions and are illustrated by choropleth shading via GIS. The upper Mississippi and its tributaries in the Iowa Basin yield the highest nitrate concentrations. These areas are associated with coarser soil types and a larger acreage of harvested corn. The nitrate load in three distinct regions significantly increased between 1980 and 2010, yet each was located in a strong or historically intensified corn production area. Overall, the rising concentrations may be linked to an increase in corn agriculture, which demands high amounts of nitrogen fertilizer, and the switch to urea – a nitrogen source more prone to leaching.

22. Grace Pullen
The University of Tennessee, Knoxville
Faculty Mentor: Dr. Heidi Goodrich-Blair

Investigating Bacterial Pigmentation and Its Role in Stress Resistance and Intestinal Colonization

Many bacteria possess traits that allow them to maintain mutually beneficial partnerships with animal hosts. The bacterium Xenorhabdus griffiniae is an experimentally tractable model to investigate these traits. The bacterium colonizes the intestine of an animal: the nematode Steinernema hermaphroditum, and together this pair infects, kills, and reproduces within insect prey. The adaptation of the bacteria to the changing environmental conditions they encounter in their nematode and insect hosts is unclear. In this work we investigated a variant of the bacterium that produces a dark-brown pigment, compared to the rust-colored pigment produced by the original variant. We hypothesize that the dark-brown pigment is protective from environmental stresses, encountered inside or outside the nematode, and potentially impact its ability to thrive within the nematode-host environment. We aim to test how two types of stress— toxic oxygen species damage and ultraviolet ray damage—affect these different strains. By investigating the dark-brown pigment producing strain, we aim to improve our understanding of the trait's role in both stress response and the nematode-host lifecycle. Ultimately, we will gain insight into how bacterial populations adapt to changing environments and how these adaptations affect their mutually beneficial and harmful relationships with animals.

23. Anna Sherrill
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Azad Hossain

Developing Models to Study Water Quality in the Tennessee River Using Remote Sensing

Remote sensing is an accessible way to quantify water quality parameters globally. Quantitative estimation of water quality parameters is complex due to variations in local topography, geology, and complex hydrodynamics. Specialized models are necessary to ensure accuracy. Due to the optical complexity of the Tennessee River, there are limited remote sensing-based water quality studies for the river. There're currently no existing models to quantify and estimate chlorophyll for the Tennessee River. Using NASA's Landsat satellites, existing turbidity models for the Tennessee river will be strengthened, and chlorophyll estimation models will be created. Using real-time in-situ measurements, linear and non-linear regression models are developed. Surface reflectance values obtained by single and multiple bands are used to develop water quality estimation models. As part of the NASA ROSES Research Initiation Award Research Program, this project is ongoing. Research includes a comprehensive literature review of turbidity and chlorophyll modeling, application of models on Google Earth Engine's Python interface, analysis of field sampling techniques, and the creation of an interactive ArcGIS StoryMap and Web-based GIS Dashboard. The developed models, and the associated project deliverables, will help researchers and citizens understand the impact of urbanization along the Tennessee River and can help facilitate sustainable developments.

24. Jacob Rodriguez
Tennessee Tech University
Faculty Mentor: Dr. Bruce Jo

Implementation of Camber Morphing Wing Mechanisms for a Small Fixed-Wing UAV

This project implemented camber morphing mechanisms and their control system from both design and practical implementation perspectives. Wing morphing technologies aim to make aircraft more energy- and aerodynamically efficient during flight by actively adjusting the wing shape. However, many technical articles often overlook the design and practical implementation of these mechanisms.

Thus, we investigated morphing mechanisms, the principles of their design, and methodologies from an implementation and test flight perspective, analyzing trends and evaluating progress to aid researchers in selecting methodologies that could transition into the design/build stages and autonomous control. Finally, we implemented a functional control system for a morphing mechanism.

The morphing mechanisms were categorized into three types: 1) structure-based, 2) material-based, and 3) hybrid. Most structure-based camber morphing mechanisms have distinctive structural features, while material-based camber morphing mechanisms rely on material properties and tools to enhance the elastic nature of their structures. Lastly, hybrid morphing mechanisms combine elements of both categories. Among these, structure-based mechanisms utilizing linear actuators, which enable the morphed shapes to be maintained under significant aerodynamic pressure, were considered.

In conclusion, this project aimed to design and control structure-based morphing mechanisms and wings by integrating materials, actuators, internal and external structural designs, and overarching process and design methodologies. The goal was to implement these advancements with a focus on futuristic and practical aspects of flight performance and applications.

25. Brooke Dinnes
East Tennessee State University
Faculty Mentor: Dr. Suman Dalal

Ataxia Telangiectasia-Mutated Kinase Deficiency Induces Cardiac Dysfunction with Increased Myocyte Apoptosis, Hypertrophy, and Fibrosis with Age

Heart disease is the leading cause of death globally, increasing exponentially with age. Mutations in Ataxia telangiectasia-mutated kinase (ATM) gene lead to a multisystemic disease called Ataxia Telangiectasia (A-T), exhibiting signs of premature aging. A-T heterozygotes (~2% of population) are susceptible to heart disease and die ~11 years earlier compared to non-carriers. ATM deficiency increases myocyte hypertrophy and fibrosis in 4-month-old (young) ATM heterozygous knockout (hKO) mice vs. wild-type (WT). However, there was no difference in myocyte apoptosis and cardiac function between the two groups. Hypothesis: It is hypothesized that ATM deficiency with age induces myocyte apoptosis, hypertrophy, fibrosis, and cardiac dysfunction. M-mode images were used to measure fractional shortening (%FS) and ejection fraction (%EF) in young and 14-month-old (old) WT and hKO mice. Heart cross-sections were used to measure myocyte apoptosis, hypertrophy, and fibrosis. Heart function (%FS and %EF) remained unchanged in young and old WT mice. However, %FS and %EF were significantly lower in old hKO vs. young hKO and old WT. Myocyte apoptosis, hypertrophy, and fibrosis were significantly higher in old hKO vs. age-matched WT. Thus, ATM deficiency induces cardiac dysfunction with increased myocyte apoptosis, hypertrophy, and fibrosis with age.

26. Malak Moustafa
The University of Memphis
Faculty Mentor: Dr. Amy Curry

The Effect of Transcranial Magnetic Stimulation Coil Orientation on Treatment Efficacy for Clinical Depression

Transcranial magnetic stimulation (TMS) is a non-invasive technique effective in treating mental disorders like depression by applying magnetic fields to specific brain areas to induce electric currents. Depression is characterized by hypoactivity in the left dorsolateral prefrontal cortex (DLPFC) and hyperactivity in the right DLPFC. High-intensity repetitive TMS targeting the left DLPFC is an FDA-approved treatment for drug-resistant depression. However, individual variations in brain anatomy influence the ideal stimulation location, and coil orientation can further impact TMS efficacy by altering electric field (E-field) distribution and activation volume. This study used SimNIBS 4.0.1 to simulate TMS at four common DLPFC stimulation sites, representing various placement techniques. For each location, three coil orientations (Nz, FCz, and Oz) were tested while other parameters remained constant. Results revealed significant differences in TMS outcomes based on coil orientation. Nz and Oz orientations produced similar results, while FCz yielded lower E-field strengths but higher activation volumes. The impact of coil orientation varied with stimulation site, underscoring the importance of individualizing TMS protocols. These findings suggest that customizing coil orientation based on the target region and patient anatomy can optimize therapeutic outcomes, improving the efficacy of TMS for treating depression.

27. Kara M. Simmons
Tennessee State University
Faculty Mentor: Dr. Marjan Rafat

Observing Metabolic Changes in Normal and Hypertrophic Adipocytes Pre- and Post-Radiation Therapy In Vitro

Triple Negative Breast Cancer (TNBC) is an aggressive and difficult to treat subtype of breast cancer since it lacks expression of both estrogen receptors and progesterone receptors and the amplification of HER2, which are often targeted in treatment for other breast cancer subtypes. Ionizing radiation (IR) is often utilized to target these tumors in conjunction with surgery and chemotherapy. While effective, IR often causes normal tissue damage in the tumor microenvironment, potentially creating a pro-recurrent niche. Levels of disease-free progression in TNBC patients are often lower than that of patients with other breast cancer types, and this is further exacerbated in patients that are overweight or obese. We evaluated the changes in adipocyte metabolism before and after radiation damage in both normal and hypertrophic adipocytes, as altered adipocyte metabolism within the tumor microenvironment has been demonstrated to impact tumor progression, especially through the secretion of fatty acids. We hypothesized by lipid-loading adipocytes *in vitro*, we could create adipocytes in culture that would reflect a metabolic profile observed in obese patients. We additionally hypothesized that these adipocytes could be more susceptible to radiation damage than their normal counterparts, influencing their post-IR metabolism and crosstalk with TNBC cells.

28. Tanner Sigears
Austin Peay State University
Faculty Mentor: Dr. Jack Deibert

Investigating a Linear Spatial Arrangement of Historic Iron Furnaces Across Middle Tennessee using Slag Glass as a Proxy

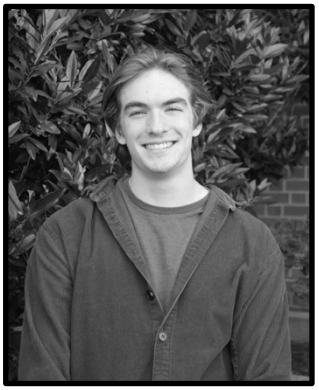
Historical iron smelting operations occur in a linear spatial pattern across Middle Tennessee, indicating a geologic control that locally concentrated the ores. The current state of the mines makes investigation challenging, however, the slag by-product left behind may serve as a proxy for the presence of overlooked critical metals. These earth resources could impact the economic development of the region. Slag glass samples provided by the Tennessee Division of Archaeology were crushed and analyzed via XRD, FTIR, and Raman spectroscopy. Additionally, polished epoxy mounts containing fragments of the samples were analyzed through micro-XRF and SEM-EDS. XRD determined the amorphous nature of the glass. FTIR and Raman identified separate iron crystals within the glass. Micro-XRF determined the major element composition (Si, Ca, Mn, K, Mg, and S) of the glass. Micro-XRF and EDS identified trace elements of Ti, Cr, Sr, Zr, and Cu. The glass is generally homogeneous, but some samples show discrete banding enriched with higher concentrations of elements than others. These variations between samples indicate anomalies within the ore body or spatiotemporal differences in production methods.

29. Isaac Puckett
Middle Tennessee State University
Faculty Mentor: Dr. Scott Handy

Investigation of a New Histidine-Catalyzed Reaction Option for the Knoevenagel Condensation for the Preparation of Potential Fluorophores

The Knoevenagel condensation reaction is a classic condensation reaction that is frequently utilized in the production of fluorophores important to biological and disease research. Piperidine is the most common catalyst, although a few reports have used amino acids, particularly glycine. We have examined the amino acid catalyzed option more closely, with a focus on glycine, histidine, arginine, or proline. Reaction rates and product yields have been compared across several reactions. The products' absorption and emission properties in response to varying levels of pH were then analyzed. The presence of histidine resulted in faster reaction rates across several reactions as compared with the presence of glycine, while proline was best for less acidic active methylene compounds. Additionally, several of the unsaturated compounds formed in these reactions are able to fluorescently signal changes in pH when in solution. The complete results for product yields, reaction rates, and the fluorescent properties of synthesized products will be presented. In future research, these fluorescent probes will be analyzed for pH-sensitivity, cytotoxic effects, and applications in biomedical research.

30. Sean O' Gorman
The University of Tennessee, Knoxville
Faculty Mentor: Dr. Stephanie Kivlin

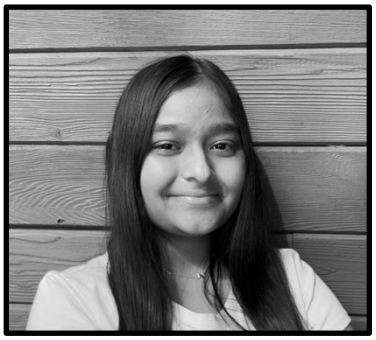


Unraveling Belowground Disruption: Assessing Stability of Below Ground Fungal Networks in the Presence of Garlic Mustard

Invasive plant species are disrupting ecological communities worldwide. Nowhere is this disruption more important than belowground where invasive plants are severing connections among native plants and their beneficial fungi symbionts, largely undetected. The fate of plant-fungal interactions in the context of global changes such as invasive plants, can be predicted by the stability of the native plant and microbial community under control conditions. One way to assess stability is by using a network-based computational approach, allowing us to better visualize and quantify relationships. We analyzed plant-fungal networks in a forest understory invaded by garlic mustard; an invasive plant that produces chemicals toxic to beneficial microorganisms. We compared plant-fungal networks in plots where garlic mustard has been weeded and those where garlic mustard was still present. We analyzed the following network statistics: linkage density, Shannon diversity, web asymmetry, and interaction evenness, that indicate network stability. We found that plant-fungal networks in invaded plots were unexpectedly more stable than weeded plots indicating that the effects of garlic mustard invasion will be difficult to reverse. Additionally, native plants varied in their response to garlic mustard invasion, with some plant species becoming disassociated more than others from the plant-fungal network. Restoration efforts should focus on rescuing the most vulnerable plants in the network, providing a pathway for reversing the effects of plant invasion on the whole plant community.

31. Diya Patel
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Hamdy Ibrahim

Fabrication of Bioactive Ceramic Coatings on Magnesium- Based Implants



The biodegradable nature and high biocompatibility of Magnesium made it a promising material for temporary biomedical implant applications. For instance, the possibility of implant removal after orthopedic surgeries due to implant failure or complications can cause severe pain and financial burden for patients and the healthcare system. Hence, there is a need for the development of efficient biodegradable implants as alternatives to the permanent ones. One of the practical ways to qualify magnesium for biomedical applications is coating them to decrease corrosion rate. Hybrid coatings, such as Plasma Electrolytic Oxidation and Sol-gel coatings, have been investigated over the past few years to enhance the corrosion resistance of magnesium alloys. This work aims to investigate the effect of changing the main parameters of the layer-by-layer Sol-gel coating process and testing the corrosion resistance of a hybrid PEO/Sol-gel coated magnesium coupons. The coated samples are characterized by morphological and corrosion characteristics using electrochemical corrosion, scanning electron microscopy (SEM), contact angle measurement, microhardness, and X-ray diffraction (XRD) tests. The result of this study investigates the effects of the Sol-gel coating with different parameters and hopes of enhancing the corrosion resistance of the PEO and Sol-gel-coated Mg coupons.

32. Olivia Hudson
Tennessee Tech University
Faculty Mentor: Dr. Hannah Kinmonth-Schultz

Examining the Effects of Biomass in Endangered Physaria globosa (P. globosa)

In this research project, three populations of *Physaria globosa* seeds, grown in different environments, were gathered, with fifteen members in each population. The first population, TN EO1, grows in a region with well-drained soil and rocky slopes. The second population, TN EO4, grows in moderately poorly drained and eroded soil. The third population, KY EO7, grows in well-drained, bare, and rocky soil. The seeds were germinated in the laboratory, and their growth was monitored. After the populations developed ten true leaves, three members from each population were selected for evaluation.

Using an LI-6800 portable photosynthesis system (LI-COR), transpiration and photosynthesis rates were measured by analyzing CO_2 exchange. Following these measurements, one leaf per plant was harvested for RNA extraction. RNA isolation was performed, followed by quantitative reverse transcriptase PCR (qRT-PCR), allowing for the quantification of RNA and providing insight into gene expression.

Analysis of plant growth characteristics revealed notable differences among the populations. TN EO1 displayed an increased root and stem weight, along with diverse leaf weights, suggesting that it likely allocates its leaf biomass on a maternal basis. TN EO4 exhibited average stem, leaf, and root weights, indicating a consistent allocation of biomass. KY EO7 had the highest leaf weight but the lowest stem and root weights, suggesting that it obtains more of its nutrients from its leaves rather than its roots due to the rocky soil.

The root-to-shoot ratio analysis revealed a higher ratio in EO1 and a much lower one in EO7. Given the soil composition, plants in EO7 appear to prioritize carbon and sugar acquisition through their leaves. As a result, they allocate a larger portion of their carbon budget to leaf biomass rather than other structures.

33. Cristiana Martinez
East Tennessee State University
Faculty Mentor: Dr. Dhirendra Kumar

Understanding the Role of SABP2-interacting Proteins (SIP) 432: a Premnaspirodiene Oxygenase Enzyme in Stress Signaling

Climate change has had a significant impact on crop yield in recent years. The increase in temperature and drought has caused a decrease in plant survival and an increase in plant pathogens that also affect plant survival. Several known plant proteins contribute to pathogen resistance and environmental stressors, but the overall metabolic pathway remains unknown. By piecing together important genes/proteins in immune response, the defense mechanisms can be better understood. This study focuses on the characterization of a SABP2-interacting protein SIP432. SIP432 is a premnaspirodiene oxygenase-like enzyme. Premnaspirodiene are 15 carbon compounds that can be converted into antimicrobial compounds by a hydroxylation reaction. The interaction of SIP432 with SABP2, a critical component of salicylic acid-mediated plant immunity, implies a role for SIP432 in plant defense signaling. A study using the Arabidopsis thaliana SIP432 knockout mutants can help understand its role in abiotic and biotic stress responses. Wild-type and sip432 mutant plants will be challenged with plant pathogens to understand their role in disease resistance pathways. All this will allow for the discovery of signaling in plant-pathogen interaction. Discovering the function of this protein could help uncover the immunity pathways and pathogen resistance in plants.

34. Blake Robinson
The University of Memphis
Faculty Mentor: Dr. Joel Bumgardner

In vitro Characterization of Cross Linked Electrospun Chitosan-Copolymer Membranes for Skin Wound Healing

Chitosan is a biomaterial derived from the exoskeleton of shrimp. Chitosan's inherent anti-inflammatory, biodegradability, and anti-bacterial properties are attractive for a variety of BME fields including bone regeneration, wound healing, and many other tissue engineering applications. Previous work has shown that the incorporation of elastin, another natural polymer, improves the biocompatibility of electrospun chitosan nanofiber membranes (ESCM) for skin wound healing but are prone to fiber swelling. Effective wound treatments must withstand aqueous environments to maintain their functionality. This work investigates the incorporation of gelatin and elastin into ESCMs, along with the use of glutaraldehyde and glyoxal as crosslinkers to enhance structural stability and prevent fiber swelling. Additionally, this study examines the capacity of neutralized chitosan membranes crosslinked with glutaraldehyde or glyoxal to support cell incorporation. Characterizations include swell ratio and in vitro cell viability with fibroblasts.

35. Zinia Hunter
Tennessee State University
Faculty Mentor: Dr. Margaret Whalen

The Role of Toll-like Receptors 3 and 4 in Hexabromocyclododecane Stimulation of Interleukin-6 Production by Human Immune Cells

Toll-like receptors (TLR) regulate the production of proinflammatory cytokines such as interleukin (IL)-6. IL-6 and other proinflammatory cytokines regulate the normal immune response to injury and infection. However, when their production is elevated in the absence of appropriate stimuli, chronic inflammation may ensue, which is associated with numerous pathologies. Hexabromocyclododecane (HBCD), a flame retardant, used in insulation, upholstery, and housing for appliances and electronics, contaminates the environment and is found in human breast milk and serum. HBCD stimulates production of IL-6 by human immune cells. As TLRs regulate production of IL-6, we hypothesize that TLRs may be involved in HBCD-induced IL-6 production by immune cells. We examined HBCD-induced increases in IL-6 production in the presence and absence of selective TLR3 (CUCPT4a) or TLR4 (TAK242) inhibitors. Results indicate that TLR4 is involved in HBCD-induced increases in IL-6 production but that TLR3 is not. These results provide important information about the mechanism by which HBCD stimulates increases in this critical pro-inflammatory protein, which has the potential for causing chronic inflammation and increasing the risk of the diseases associated with chronic inflammation such as cancer.

36. Madyson Leighann Knox
Austin Peay State University
Faculty Mentor: Dr. Kallina Dunkle

Analysis of Women's Experiences in STEM

Women have been historically underrepresented and undervalued in STEM fields, often facing barriers to both entry and retention. As part of an Institutional Review Board-approved study, focus groups are used to examine women's career motivations, experiences, and perceptions in STEM, focusing on factors that influence their educational and professional trajectories. The 90-minute focus group sessions will be audio-recorded for transcription, with participants also allowed to provide written responses. The study population includes Austin Peay State University students majoring in STEM who identify as women and are 18 or older. Eligible participants will receive a consent document detailing the study's procedures, data storage, risks, and benefits. The researchers will separately analyze transcripts for a priori or preset codes that include the importance of early support, such as mentorship and access to resources, in shaping career motivations and systemic biases, such as unequal access to leadership opportunities and persistent gender stereotypes, which remain significant barriers to success. Results will be used to develop actionable strategies to increase recruitment and retention for women in STEM fields by addressing these challenges and opportunities.

37. Jai Mehta
The University of Tennessee, Knoxville
Faculty Mentor: Dr. Scott Emrich

Defining Effector and Memory-like Cell State In in-vivo CAR T Cells from Multi-center Clinical Trials

Chimeric Antigen Receptor (CAR) T-cell immunotherapy is an emerging treatment that has demonstrated high remission rates in pediatric patients with non-solid tumors. This process involves extracting T cells (immune cells) from the patient, inserting the CAR gene, and allowing the cells to proliferate in a laboratory setting before reinfusion into the patient to target and destroy tumor cells. The inaugural recipient of CAR T-cell therapy has remained cancer-free for twelve years. Despite this success, the specific in vitro concentrations of effector and memory T cells, which are crucial subtypes for sustained immunologic response, remain poorly characterized. This lack of definition can lead to relapse if the patient's cells are imbalanced. This study utilized a Gaussian Mixture Model (GMM) to classify clinical T cell data into what are hypothesized to be effector and memory groups. Validation was conducted using data from the first patient (PT1), with UMAP Joint-Embedding confirming a significant correlation between clinical group classification and PT1's durable CAR T-cell gene expression. These findings suggest that the GMM effectively delineates patient CAR T cell phenotypes corresponding to effector and memory functions, enhancing our understanding of post-treatment T cell dynamics.

38. Tooba Tanveer
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Hamdy Ibrahim

Fabrication of Strengthened Magnesium-Based Nanocomposite

Several problems are associated with currently in-use metallic bone implants (e.g., Titanium alloys) due to the post-recovery implant removal surgeries such as possible inflammation and implant fracture. These have led researchers to investigate the use of biodegradable implants as an alternative to these permanent implants. Magnesium has been a favorable material for such biomedical applications due to its low density, degradability, and biocompatibility. This study focuses on the development of magnesium-based metal-matrix-composites reinforced by boron-nitride nanoparticles using powder metallurgy as the main fabrication technique. The fabrication steps include powder mixing, compaction and sintering, with powder mixing as the major area of focus. The parameters to be optimized are fill level of the mixing container, time for mixing and the acceleration of the mixer using a three-factor three-level factorial design. The samples created using this process are characterized by determining the density distribution of the mixed powder, density and porosity of the sample, corrosion resistance, microhardness, tensile strength, cytotoxicity, and wettability. The tests include scanning electron microscopy (SEM), optical microscopy, X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), contact angle goniometry, and electrochemical corrosion test. The goal is to achieve the best combination of strength and corrosion resistance using the optimum parameters.

39. Colin Wall
Tennessee Tech University
Faculty Mentor: Dr. Steven Anton

Initial Smart Building Validation and Simplified Model Development

Across many engineering disciplines, the development of smart building infrastructure remains a growing field of research. Smart buildings use intelligent systems to monitor the building and its occupants. These systems can utilize that data to optimize power usage, detect structural damage, and ensure occupant safety. At Tennessee Tech University, the new Ashraf-Islam Engineering Building features a vibration-based smart building system. The purpose of this project was to develop models and conduct experiments to validate this system. First, the installed accelerometers were tested to ensure they were functioning properly. Next, footstep data was collected to verify that the surrogate system developed in the Lab Science Commons was appropriate. Finally, a drop test was conducted using a crash dummy to simulate a person falling. The results from the walking and impact tests confirmed that the sensors accurately captured both high- and low-energy human-building interactions within the measurement range of the sensors.

40. Xavier Poore
East Tennessee State University
Faculty Mentor: Dr. Sean Fox

Methicillin-resistant Staphylococcus aureus (MRSA) and its Resistance Capabilities Against Lavengel

In a bacterial colony, there are some bacteria that have mutations, differing them from the rest of the colony. These mutants may have a mutation in their genes that allows the bacterium to survive against certain antibiotics. In recent years, growing use of antibiotics has resulted in many strains of antibiotic-resistant bacteria, effectively limiting our resources to fight off infections. However, a new technology known as ARAG, an antioxidant-rich gel, has demonstrated promising abilities to inhibit the growth of many prevalent antibiotic-resistant bacteria. The antioxidants help to destroy free radicals created as a byproduct of a bacteria's aerobic metabolism, as well as human's cellular metabolism. Free radicals can be any molecule that does not have a full outer electron shell. This causes the free radical to bind to specific compounds and steal one of their electrons. After the electron is stolen from a stable compound, the victim compound becomes a free radical itself. This is dangerous due to free radicals stealing from any molecule or compound. The specific ARAG used in this proposal is known as Lavengel. This proposal aims to determine if multi-drug-resistant bacteria can become resistant to this new technology. Given the likely mechanisms of anti-microbial properties involved with this gel, specifically antioxidants, could provide a safe alternative to antibiotics and slow the spread of antibiotic-resistant bacteria.

41. Jake Stewart
The University of Memphis
Faculty Mentor: Dr. Thomas Hagen

Barrier Effects on the Escape and Pursuit of an L1 Pursuer and L2 Target

In mathematical pursuit and escape games a pursuer (agent 1) tries to catch a target (agent 2) by closing the distance between them. Both pursuer and target can move if their movement is unobstructed. The distance in traditional games is taken as the Euclidean distance given in terms of the L^2-norm where the Pythagorean Theorem holds true. The effects of limiting one of these agents to movement measured in the L^1-norm and the addition of a finite, straight-line barrier, or obstacle, were investigated, both analytically and numerically. The earliest time the pursuer and target can meet defines their dominance regions. It was found that even with lower speed (up to a ratio of $\frac{1}{\sqrt{2}}$), an L^2 target can escape from an L^1 pursuer if the target takes the "optimal" path within its dominance region. Escape is defined when the target's dominance region becomes unbounded. When introducing the barrier, there are three cases for the L^1 pursuer's path: one axis of movement (AoM) blocked, both AoM blocked, and no AoM blocked. The cases with single AoM and both AoM being blocked results in global change of the dominance regions, whereas the case with no AoM blocked results in local change.

42. Ananya Arcot
Middle Tennessee State University
Faculty Mentor: Dr. Meghan Wendelken

The Effects of Audiovisual, Visual, and Orthographic Input on Language Learning in College Students

The study compares three conditions of watching a documentary, Audiovisual (AV), visual and text (VT), and audiovisual and text (AVT), to determine the highest incidental vocabulary acquisition, the correlation between existing vocabulary skills and vocabulary learning, and the differing perspectives of the documentary based on the three conditions. College students are being recruited, and a series of tests are given before and after participants watch a 25-minute selected documentary clip. Data analysis will be performed using a repeated measures ANOVA. Preliminary data has shown significant gain scores after watching the documentary, but there have been no changes in language learned among the three conditions with fill-in-the-blank scores.

43. Jackie Liu
The University of Tennessee, Knoxville
Faculty Mentor: Dr. Michael Danquah

Surface Plasmon Resonance Analysis of IsdA- Aptamer Binding Interaction

Aptamers are single stranded nucleic acids that are selected for their high affinity and specificity to target molecules by folding into secondary or tertiary structures dependent on their binding environment. They hold immense potential in various biomedical applications such as targeted drug delivery, biosensing, and diagnostics. Aptamers can be used to develop novel biosensors for accurate, real-time detection of pathogens such as *Staphylococcus aureus (S. aureus)*. In this study, experimental analysis of the binding behavior of an iron-regulated surface determinant protein A (IsdA)-binding aptamer is conducted through surface plasmon resonance (SPR) measurements to develop a deeper understanding of the aptamer characteristics. IsdA, the surface protein of the foodborne pathogen *S. aureus,* plays a significant role in the survival and colonization of the pathogen. Therefore, enhanced detection of this protein provides opportunities for accurate, real-time pathogen detection. Electrochemical tests, including cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS), will be utilized alongside SPR to provide further insights into the aptamer-IsdA interaction. These techniques will help characterize the binding kinetics, thermodynamics, and specificity of the aptamer-IsdA interaction, offering insights into the binding mechanism and performance. CV will assess the electrochemical behavior and charge transfer properties, while EIS will reveal the impedance characteristics of the aptamer-modified surface. The findings from this project will be critical in benchmarking the performance of biosensors developed from the aptamer.

44. Logan McCollough
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Mohammad Mahtabi

Defect Reduction in 3D-Printed Parts for Higher Tensile Strength

Additive manufacturing (AM), also known as three-dimensional (3D) printing, is the technology of making solid objects through layer-by-layer addition of material based on a computer drawing. AM is a powerful and flexible fabrication technique that has gained significant popularity in various applications, from aerospace to biomedical industries. This technology, by overcoming the difficulties in the fabrication of complex geometry, is a promising method for more complex geometry and realizing remote fabrication. Ensuring strong and durable components in critical aerospace, biomedical, and energy applications is vital for minimizing catastrophic failures. The current state-of-the-art AM machines produce parts that are full of defects of micron and sub-micron size, which limits the application of AM parts toward structural components. We are proposing a novel method to improve the quality of the AM parts by reducing the size and number of unintentional defects that form during the AM process. A modified printing process was used by vibrating the build plate to improve the bonding of the deposited layer and, thus, reduce the unintentional defects. The effect of the amplitude and frequency of the vibration on the quality and mechanical properties of the fabricated part was studied and discussed.

45. Olivia Williams
East Tennessee State University
Faculty Mentor: Dr. Joshua Samuels

Description and Morphometric Comparison of Early Pliocene Deer (Cervidae) from the Gray Fossil Site of Northeast Tennessee to Modern and Fossil Cervids

The early Pliocene Gray Fossil Site (GFS) of Northeast Tennessee is well-known for its diverse and abundant fossil record. Here, we describe the first remains of deer from the site, which include several teeth, a partial humerus, 2 tibiae, astragalus, calcaneum, and 2 proximal phalanges. Both qualitative and quantitative comparisons have been made to a wide range of modern and fossil cervids, including early Pliocene Eocoileus gentryorum and Bretzia pseudalces, late Pliocene Odocoileus brachyodontus and Capreolus constantini, early Pleistocene O. virginianus, and extant O. virginianus, O. hemionus, Cervus elaphus, Capreolus capreolus, and Mazama americana. We have gathered 4 measurements from the upper dentition and 18 from postcranial elements. Comparisons show that the Gray Fossil Site deer falls within the variation range of the early Pliocene Eocoileus gentryorum from Florida. The similarities between Eocoileus and extant deer (Odocoileus spp.) suggests they occupied a similar niche and may indicate that deer have been filling the same role in Appalachian forests for nearly 5 million years.

46. Mira Umarova
The University of Memphis
Faculty Mentor: Dr. Philip Kohlmeier

Co-option of Two N-alkanes as a Brood Pheromone Modulating Foraging Preferences in Temnothorax Ant Workers

In social insects, specialized foragers fulfill the nutritional needs of all colony members. This study investigates the chemical cues used by *Temnothorax longispinosus* ant larvae to increase protein-foraging in foragers. Based on previous chemical analyses, we tested whether two larva-biased n-alkanes function as brood pheromones. Colonies lacking brood were exposed to synthetic versions of n-C27 and n-C29, which are more abundant in larvae than in workers. A combination of n-C27 and n-C29 increased protein-foraging to the same level as full larval Cuticular hydrocarbon extracts, while n-C27 and n-C29 individually did not elicit the same response. n-alkanes can be found across insects and are involved in waterproofing the cuticle. Our findings provide the first evidence that a combination of two specific n-alkanes has been co-opted to additionally function as a brood pheromone in ants, influencing worker behavior to meet larval nutritional needs. This suggests a quantitative mechanism where the relative abundance of these compounds plays a key role. Understanding these chemical communications offers insights into colony homeostasis and social behavior evolution in ants. Our findings contribute to a broader understanding of how chemical signals mediate complex social interactions in eusocial organisms, providing a foundation for future studies on chemical communication.

47. Shelby Mayhut
Middle Tennessee State University
Faculty Mentor: Dr. Daniel Erenso

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

This research utilizes AI-assisted code and modern physics laws to analyze video footage of red blood cells from biomass waste during laser ionization. The aim is to profile the emission spectrum of the blood cell plasma, akin to a star's emission profile, while exploring biomass waste for renewable energy. By applying Stefan-Boltzmann's and Wien's displacement laws, we model the thermal radiation characteristics of ionized blood cells, identifying key spectral features such as wavelength, color, temperature, and intensity. The AI-assisted code breaks down the plasma's illumination into these spectral components by analyzing the light emitted at different wavelengths, which correspond to different colors and temperatures, and measuring the intensity of the emitted light. These features reveal how blood cells store and release energy from infrared laser light. Previous studies demonstrated significant energy storage and emission potential in blood samples. Our current focus is on computational analysis of the ionized blood sample's emission spectrum to enhance understanding of electromagnetic properties in biomass-derived red blood cells, supporting the broader goal of renewable energy solutions. The implications of this research include advancements in renewable energy, medical diagnostics, interdisciplinary scientific discoveries, and environmental sustainability.

48. Summer Eaker
The University of Tennessee, Knoxville
Faculty Mentor: Dr. Benjamin P. Keck

Preservation Methods and Microplastic Detection in Fishes

Microplastics are now commonplace in everything from the oceans and rivers to blood, and human tissue. The accumulation of plastics within the human body has been found to cause health problems relating to respiratory, cardiovascular, and digestive systems. Fish are relied on as a source of food for people around the world, therefore microplastic contents within their tissues is worrisome. While many studies have extracted microplastics from fish sampled from different environments, none have asked if preservation method affects microplastic discovery. A sample of forty Tennessee Shiners, Leuciscidae: *Notropis leuciodus*, specimens were sampled from the Little River at 411 bridge in Blount Co., TN, at the same time with half preserved using a standard protocol and half kept on ice. We found microplastics in nearly all specimens and compared counts from the 2 preservation methods. There was no significant difference between the two preservation methods.

49. Angelica Lance
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Deanna Beasley

Observing Detritivore Communities in Urban Bioretention Gardens

Decomposition is one of the most important ecological processes due to its role in nutrient cycling and is highly dependent on the presence of organisms that help break down organic material (i.e. detritivores). Decomposition in urban environments may be altered due to an increase in modified land cover and the consequential absence of detritivores. Bioretention basins are primarily engineered for stormwater management in urban areas yet may also serve as a refuge for urban detritivore communities when designed to support plant biodiversity. However, the detritivore communities that are supported in bioretention basins are relatively unknown. This study aims to investigate and analyze the detritivore communities of two bioretention gardens in Chattanooga, Tennessee for the purpose of providing a baseline for understanding urban detritivore community structure. Leaf litter bags were placed in the gardens for 2-3 months and organisms were isolated using a Berlese funnel. Organisms within the samples were identified to the family level and a Shannon-Wiener index was calculated as a measure of community diversity. We compared community diversity between gardens using a Student t-test. Our findings will potentially inform decisions in bioretention planning and promote future research of the state of urban biodiversity and other ecological processes in urban green infrastructures.

50. Erica Tocholke
East Tennessee State University
Faculty Mentor: Dr. Aleksey Vasiliev

Functionalized Hybrid Materials for Clean-Up of Water Contaminated by Nitrates

The presented innovation addresses the critical environmental issue of elevated nitrate levels in water bodies, primarily due to excessive use of nitrogenous fertilizers and improper waste disposal. It leads to detrimental effects like eutrophication and health hazards. Focusing on the necessity to reduce nitrate concentrations in contaminated water to permissible levels, the effectiveness of hybrid organic-inorganic materials in nitrate adsorption was explored in this work. Mesoporous amino-functionalized silica materials were synthesized by grafting and sol-gel techniques. The surface amino groups of the materials were converted to amine hydrochlorides for easy ion exchange on nitrate cations. The chemical compositions and structural characteristics of obtained adsorbents with high BET surface area were examined by elemental analysis, FT-IR spectroscopy, porosimetry and particle size analysis. Batch adsorption tests proved high nitrate adsorption capacities of these materials. Sol-gel materials demonstrated the highest efficiency attributed to their abundant amino group contents. Among them, the surfactant-free sol-gel material was selected as the best adsorbent due to its ease of synthesis and cost-efficiency. The study of the effect of temperature on nitrate adsorption showed its high performance in the wide range of naturally occurring climatic conditions. Obtained adsorbents remained highly efficient in five adsorption/regeneration cycles. This study contributes significantly to the development of efficient methods for nitrate removal from water, presenting a promising approach for environmental remediation.

51. Esme' Keszler
Middle Tennessee State University
Faculty Mentor: Dr. Kevin Downs

Nutritional Value and Degradability of Sunn Hemp (Crotalaria juncea) in the Bovine

This study will yield the nutritional value and degradability of sunn hemp when studied in the bovine rumen. Sunn hemp is currently used as a valuable cover crop. This study will further determine whether this crop would also be an ideal forage for cattle and other ruminant species. Using a rumen degradability in situ technique, the crop's ability to degrade in the rumen will be examined. Different incubation times will allow for the analysis of the degradability over time in the rumen. Through further research, sunn hemp could become a more commonly used forage source and dually useful in the agricultural field. Sunn hemp could be used to provide forage to cattle, while also performing as a cover crop and enriching the soil.

52. Alyssa Matthews
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Jared Pienkos

Synthesis of Tpm ligands using C-F activation, subsequent functionalization, and coordination to a Mn (I) metal center

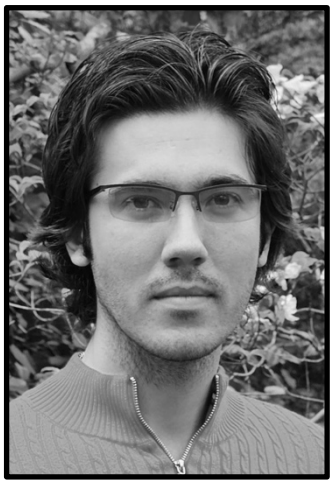
Trispyrazolylmethane (Tpm) ligands and their associated metal complexes are commonly utilized in medicinal chemistry and catalytic applications. Of note, [TpmMn(CO)3]PF6 and its derivatives has been investigated for their controlled release of carbon monoxide, which has medicinal applications. A unique way to prepare Tpm ligands involves the C-F activation strategy that exploits a quinoidal intermediate of aniline or anisole derivatives. Here we present a strategy to generate substituted Tpm ligands of the form H2NPh(Rpz)3 utilizing 4-(trifluoromethyl)aniline, KOH, and Rpz (where Rpz is a 4-substituted pyrazole). We also investigated the functionalization of the –NH2 on H2NPh(Rpz)3 derivatives. For example, we found H2NPh(pz)3 can be acylated with acryloyl chloride. We also investigated coordination of H2NPh(Rpz)3 derivatives with a [Mn(CO)3]+ metal fragment. We found that H2NPh(pz)3 reacts with Mn(CO)5Br, and following a NH4PF6 counterion exchange forms [H2NPh(pz)3Mn(CO)3]PF6. The identity of this newly formed transition metal compound was verified by 1H-NMR spectroscopy and crystals of [H2NPh(pz)3Mn(CO)3]PF6 were grown by layering an acetone solution of our complex with hexanes. Under these conditions, [H2NPh(pz)3Mn(CO)3]PF6 crystalizes as an acetone solvate in space group P21/c with sheets of the complexes assembled via N-H--F and C-H--F intermolecular interactions.

53. Rachel England
East Tennessee State University
Faculty Mentor: Dr. Sean Fox

Quantitating the Effects of a Klebsiella Bacteriocin on E. cloacae Models

Antibiotic resistance has emerged as a pressing global health threat, with drug-resistant infections contributing to nearly 5 million deaths worldwide. To address this crisis, bacteriocins have been studied as a possible alternative to traditional antibiotics. Bacteriocins are antimicrobial peptides produced by bacteria to inhibit the growth of closely related strains. Klebsiella pneumoniae produces a bacteriocin that inhibits the growth of Enterobacter species, such as E. cloacae, which is a significant source of healthcare-associated infections. This project aims to quantitate the inhibitory effects of this bacteriocin on E. cloacae in planktonic culture, biofilm, and C. elegans models. A fluorescent reporter strain of E. cloacae was produced by transforming plasmids containing the RFP gene into wild-type E. cloacae via electroporation. Antimicrobial susceptibility testing was then performed on planktonic cultures, showing that cultures treated with the Klebsiella bacteriocin had a reduction in CFUs compared to untreated cultures. Currently, crystal violet biofilm assays are being performed to determine the optimal technique for similar fluorescent assays. In the future, C. elegans will be used as an in vivo infection model. The results of this research will hopefully demonstrate the potential of this bacteriocin as a synergistic treatment for drug-resistant Enterobacter infections.

54. Brenden Lippard
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Erkan Kaplanoglu



Exoskeleton Glove for Stroke Rehabilitation

Each year in the United States almost 800,000 people have a stroke, which may severely affect hand function. Rehabilitation following a stroke is crucial for restoring strength, range of motion, and neural control. Wearable robotic systems for passive-assisted motion therapy, active-assisted motion therapy, and robotic mirror therapy improve motor recovery and functional abilities for patients and allow user-directed therapy at home. Popular pneumatic gloves for home-based rehabilitation are limited by their lack of fine-grained control and data analytics to track progress effectively. This project introduces a method of using a hand tracking camera to provide continuous monitoring and control of finger movements within a rigid exoskeleton glove. The exoskeleton glove uses linear actuators to control the position of each finger independently, based on the angle of the fingers measured by the hand tracking camera. The system can track both the hand wearing the exoskeleton glove and a different hand, enabling several robotic therapy modalities and a broader range of rehabilitation exercises. This mobile system enables data collection and detailed analytics of exercises to allow for evaluations of progress and adherence to a rehabilitation program at home. This hand tracking exoskeleton glove demonstrates a rehabilitation technology that can transform the recovery process for patients by monitoring progress over time and putting control of the rehabilitation process in the user's hands.

55. Abbey Laughlin
East Tennessee State University
Faculty Mentor: Dr. Suman Dalal

Cardiac Myocyte-Specific Deletion of Ataxia Telangiectasia-Mutated Kinase (ATM) Induces Left Ventricular Dilation and Systolic Dysfunction

Mutations in ATM gene cause an autosomal disease known as Ataxia-telangiectasia. Whole-body ATM knockout (KO) mice die ~2 months of age. At this age, mice exhibit reduced left ventricular (LV) dilation with no change in systolic function versus wild type. This study investigated if cardiac myocyte-specific deletion of ATM in mice induces LV dilation and cardiac dysfunction. Cardiac myocyte-specific ATM KO mice (fl/fl/cre) and their controls (flox/flox; fl/fl) were generated by cross breeding of ATM flox/flox and αMyHC-cre mice. Cardiac structural and functional parameters were measured using echocardiography. M-mode images were used to measure percent fractional shortening (%FS), percent ejection fraction (%EF), LV end-systolic (ESD) and end-diastolic (EDD) diameters, end-diastolic (EDV) and end-systolic (ESV) volumes in mice aged 4 and 8 months. Cardiac myocyte-specific deletion of ATM significantly increased EDD in fl/fl/cre versus fl/fl mice aged 4 months. However, a significant decrease in %FS and %EF was observed in fl/fl/cre versus fl/fl mice aged 8 months. Conversely, fl/fl/cre exhibited a significant increase in ESD, EDD, ESV, and EDV versus fl/fl mice. Thus, cardiac myocyte-specific deletion of ATM induces LV dilation in mice aged 4 & 8 months and systolic dysfunction in mice aged 8 months.

56. Barbara Higgs
The University of Tennessee at Chattanooga
Faculty Mentor: Dr. Jared Pienkos

Synthesis of heteroleptic Ru (II) and Ir (III) compounds with the N-oxide functional group

Compounds containing the N-oxide functional group and transition metal compounds (e.g., Ir (III) derivatives) are of interest due to their ability to function as imaging agents. For instance, in hypoxic conditions, the N-oxide can be reduced to its non-N-oxide form, which has been exploited in imaging low oxygen concentrations. Herein, we present the synthesis of a new library of transition metal N-oxide containing compounds of the form (R ppy) 2 Ir(N^O) and (bpy) 2 Ru(N^O) (where H R ppy is a 2,4-diphenylpyridine or 2-phenylquinoline, and N^O is a picolinate type ligand) and their corresponding non-N-oxide derivatives. All Ir (III) species were formed by reacting an Ir (III) chloro-bridging dimer with K 2 CO 3, and acipimox or its non-N- oxide counterpart. Ru (II) compounds were synthesized using cis-Bis(2,2′-bipyridine) dichlororuthenium, NH 4 PF 6, and acipimox or its non-N-oxide analog. Compounds were characterized by NMR, X-ray crystallog., CV, UV-vis, and emissions spectroscopy. Preliminary data indicates that the N-oxide acts as an electron-withdrawing group, and quenches emissions relative to the non-N-oxide.

57. Seth Hatchett
The University of Tennessee at Martin
Faculty Mentor: Dr. Saman Sargolzaei

The Frequently Overlooked Importance of Cybersecurity in Agricultural Operations

This work explores the increasing cybersecurity risks faced by modern agricultural operations, which are heavily dependent on technology such as sensors and automated systems for efficient production. Given agriculture's critical role in global food security, cyberattacks targeting these systems can lead to significant financial losses, operational disruptions, and food shortages. The study identifies various motivations for these attacks, including financial fraud, activism, and the theft of proprietary agricultural information. Drawing on case studies of recent cyber incidents, the work illustrates the widespread impact of such attacks on the agricultural sector, from small farms to global food supply chains. It also provides actionable recommendations for enhancing agricultural cybersecurity, including strategies for password management, access control, software updates, and employee training. Strengthening cybersecurity measures in agriculture is essential to protect the food supply, mitigate economic risks, and ensure the resilience of global agricultural systems.

58. Jonathan Barber
The University of Tennessee at Martin
Faculty Mentor: Dr. Ali Seyedkavoosi

Translational Dynamic Insulation System for Switchable Building Envelopes

A large percentage of residential and commercial energy usage is spent on indoor space conditioning; in the past, dynamic insulation systems (DIS) have been utilized to decrease this demand on the electrical grid. Our goal is to implement a system that uses the translational movement of an insulation layer found within a wall cavity. The gap created by the insulation layer's movement allows radiation and natural convection to occur between the exterior cladding and interior finishing of the building envelope. An initial analytical model shows potential to achieve thermal resistance values ranging from 1.56-2.88 $m^2°K/W$ (8.83-16.37 $ft^2 \cdot °F \cdot hr/BTU$). This is important because, when closed, the system can achieve the highest recommended R-value for zone four of the United States, while when fully opened, much lower R-values than recommended are observed. Based upon the findings with the analytical model, a proof-of-principle prototype has been constructed to test the system's effectiveness by controlling the motion of the dynamic insulation layer. Overall, this research shows great potential in creating a system capable of reducing commercial and residential energy expenditure by varying a wall's thermal resistance.

59. Joshua Townsend
The University of Tennessee at Martin
Faculty Mentor: Dr. Ali Seyedkavoosi

Modern Prosthetic Devices

Modern prosthetic devices commonly utilize electromyography (EMG) sensors to facilitate user control by detecting muscle activation. Typically, multiple EMG sensors are strategically placed to interpret a variety of muscle signals, allowing for precise movement control. However, deploying numerous sensors can complicate device design, increase cost, and reduce comfort. In this research, we explore the feasibility of developing a functional prosthetic arm controlled by a single EMG sensor. To achieve this simplification without sacrificing functionality, we integrate pressure sensors in the fingertips of the prosthetic. These fingertip sensors provide supplementary input data, enabling the prosthetic device to accurately interpret user intentions and perform nuanced movements despite using fewer EMG sensors. This study aims to streamline prosthetic design while maintaining effective and intuitive user control.

Posters at the Capitol Organizing Committee

Dr. Cindy Taylor, Austin Peay State University
Professor, Biology

Dr. Cerrone R. Foster, East Tennessee State University
Director, Undergraduate Research and Creative Activities

Dr. Jamie Burriss, Middle Tennessee State University
Director, Undergraduate Research Center

Casey Penston, Middle Tennessee State University
Coordinator, Undergraduate Research Center

Dr. Kevin Ragland, Middle Tennessee State University
Associate Director, Tennessee STEM Education Center

Lindsay Randolph, Middle Tennessee State University
Coordinator, Tennessee STEM Education Center

Sherry Shafer, Middle Tennessee State University
Program Assistant, Tennessee STEM Education Center

Dr. Lenly Weathers, Tennessee Tech University
Associate Professor, Civil and Environmental Engineering

Dr. Tom Byl, Tennessee State University
Assistant Professor, Civil and Architectural Engineering

Dr. Margaret Whalen, Tennessee State University
Professor, Chemistry

Dr. Melinda Jones, The University of Memphis
Director, The Helen Hardin Honors College

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Dr. Janna Caspersen, The University of Tennessee, Knoxville
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