ALABAMA SCHOOL OF MATHEMATICS AND SCIENCE
2025 SPRING RESEARCH FORUM

The Spring Research Forum is an academic conference presenting the scholarly activities of the ASMS Research Fellows Program.

Schedule of Events

ASMS Dragon Legacy Distinguished Alumni Lecture

Dr. John de la Parra, c/o 1998
2:15 pm - Auditorium

Paper Presentations & Panel

3:00 pm – 4:20 pm

Wilson Science Research Center 107

3:00 pm *Quantum Theory Prediction of Anionic Metal-Oxide Catalyst Efficiency for Methane-to-Methanol Conversion* – ***Daniel Pacheco***

3:20 pm *Designing RNAi Pesticides to Specifically Target Invasive Species* – ***Madeline Borchert***

4:00 pm *Alumni-Student Networking Panel – Engineering*

Wilson Science Research Center 109

4:00 pm *Alumni-Student Networking Panel – Law, Nonprofit, Leadership, Business, and Education*

Wilson Science Research Center 118

3:00 pm *Asphalt Loss Due to the Effects of Precipitation* – ***Derek Ricafort***

3:20 pm *Subversion or Enforcement? The Victorian Sensation Novel and its Relationship with Gender* – ***Brooke Andrews, Adelaide Deputy***

3:40 pm *Statistical Analysis & Prediction of the 2024 Presidential Election* – ***Fatima Imran, Averionna Sierras***

Wilson Science Research Center 227

3:00 pm *Alabama oysters taste best with tabasco, not ocean acidification: In the Northern Gulf of Mexico, how does ocean acidification affect the homeostasis and physiological responses including growth, immunity, and maintenance of the Crassostrea Virginica?* – ***Lillian Abernathy, Naria Khristoforova, BoKyeong Kim, Hyerin Park, Kayty Phan, Emma Kate South***

Wilson Science Research Center 208

3:00 pm *Medtrack: Noninvasive Tracking of ADHD Medication in the Body Novel Synthetic Derivatives of Vitamin B3 and their Mode of Action* – **Amna Hadi, Ruitong Jin, Lilly Nguyen, Davis Stephenson**

3:20 pm *The Effect of Language Erasure on Culture in Africa Town* – ***Jenna Wood***

3:40 pm *Forgotten History: The Language of Descendants* – ***Jayla Daughtry***

Poster Session

3:00 pm - 4:00 pm
Wilson Science Research Center: 1st and 2nd Floor Hallways
Bedsole Art Gallery

ASMS SRF is sponsored by: AIRBUS spire

ALABAMA SCHOOL OF MATHEMATICS AND SCIENCE

2025 SPRING RESEARCH FORUM

Abstracts

(alphabetical order)

Alabama oysters taste best with tabasco, not ocean acidification: In the Northern Gulf of Mexico, how does ocean acidification affect the homeostasis and physiological responses including growth, immunity, and maintenance of the Crassostrea Virginica

Lillian Abernathy, Naria Khristoforova, BoKyeong Kim, Hyerin Park, Kayty Phan, Emma Kate South

Ocean acidification is driven by increased carbon dioxide in the atmosphere which causes a decrease in carbonate ion concentration in the ocean. As a result, the decline in carbonate ion concentration causes calcifying marine organisms, such as the Eastern Oyster, *Crassostrea virginica*, to experience a decline in proper shell formation. *C. virginica* is a prominent organism in the Gulf of Mexico that is experiencing the negative effects of ocean acidification. The study aims to investigate the effects of ocean acidification on homeostasis and physiological responses including growth, immunity, and maintenance of *C. virginica* and predicts *that ocean acidification correlates to a negative response in genes controlling growth, tissue apoptosis, nitrogen cycling, shell production and infection susceptibility*. Preliminary qPCR data suggests that gene amplification targets indicate a stress response in both laboratory and in situ experimental samples, echoed by wet weight tissue analysis. Overall, these findings may indicate economic impacts as well as ecological. *Mentors: Dr. Rebecca Domangue, Dr. Natalie Ortell.*

The Application and Development of Artificial Intelligence and Bioinformatics on Cancer Research

Emily Tran

Bioinformatics is an interdisciplinary scientific field that combines computer science, math, statistics, and databases to develop software and tools for storing, analyzing, and interpreting biological data. Throughout the years, numerous advancements in cancer research, particularly in diagnosis and treatment, have been made with bioinformatics. The integration of Artificial Intelligence (AI) has further developed those advancements due to its ability to effectively analyze large bits of data. This allows researchers and medical professionals to provide patients with a more precise diagnosis and personalized treatments faster. However, the "black box" nature of AI models–meaning they lack transparency and reliability–introduces uncertainty. Aiming to solve this problem, efforts in improving AI algorithms to provide clearer insights and better reasonings are being implemented. Additionally, user-friendly platforms that incorporate visualizations and AI-driven interpretations are being created–making complex data more accessible for both researchers and the general public. These advancements with AI in bioinformatics and cancer research highlight its potential for further improvements. *Mentor: Mr. Grey Gaillard.*

Asphalt Mass Loss Due to the Effects of Precipitation

Derek Ricafort

Open Graded Friction Course (OGFC) is a thin layer of porous asphalt spread over more densely packed asphalt to allow better drainage of surface liquid. There is currently a lack of research in understanding the optimal times for maintenance for OGFC. Finding a proper maintenance time is crucial, especially when considering high temperatures and heavy traffic loading causing the most damage to OGFC. In this study, we designed a precipitation simulator that included a filtration system, a continuous water assembly, and a transparent box to contain asphalt test samples. Our precipitation simulator records different temperatures and water pressures while analyzing the effects on various asphalt samples. *Mentors: Charles Turner, Dr. Shenghua Wu, University of South Alabama.*

Caldesmon as a Marker for Pericytes in Human and Mouse Brain

Jacob Kim

Pericytes are mural cells that wrap around capillaries, support the blood-brain barrier, and degenerate in neurodegenerative diseases, including Alzheimer's disease. Being able to visualize pericytes in post-mortem brain tissues is important for understanding their role(s) in health and diseases. Currently, there are 1-2 antibodies that recognize mural cells, including pericytes, somewhat selectively and reliably. Using recent RNAseq data, we identified that caldesmon expression is primarily in mural cells including pericytes and vascular smooth muscle cells. Caldesmon is a protein that can be found in pericytes that inhibits the binding of actin and myosin therefore leading to relaxation. This project sought to determine whether caldesmon antibodies could be used to identify pericytes in mouse and human brain tissues. Using immunohistochemistry, we stained mouse and human postmortem brain tissues with antibodies previously demonstrated to be specific to pericytes (CD13), and caldesmon, and a fluorescently conjugated dye to label endothelial cells forming blood vessels (lectin). We next used fluorescently labeled secondary antibodies to visualize and image pericytes. Then, we used ImageJ to count caldesmon and CD13 positive cells on capillary segments. *Mentor: Dr. Amy Nelson, University of South Alabama.*

Chaotic Dynamics of a Magnetic Pendulum in a Fluctuating Magnetic Field

Jesus Flores, Robert Trifas

In modern industry, many systems rely on electromagnets to control mechanical switches, such as in motors, sensors, and actuators. Many of these systems encounter issues when electromagnetic field perturbations cause moving parts to undergo chaotic motion. In this study, a simple pendulum with an electromagnet attached to its end is used. The end of the pendulum is excited using a solenoid, and data is collected on the motion of the pendulum and the strength of the magnetic field. This data was compared to simulation to observe what parameters cause the motion of the pendulum to become chaotic. *Mentor: Dr. Mark Byrne.*

Comprehensive Analysis of mircoRNA Processing Enzyme Dependencies

Kingston Barnes, Kimberly Gregson, Kahyeon Jeon, Alayla Roussell

MicroRNAs (miRNAs) are a class of noncoding RNAs (ncRNAs) that are approximately 20 nucleotides in length with essential regulatory roles in cell proliferation, differentiation, apoptosis, and metabolism. Changes in the expression of numerous miRNAs have been linked to the pathogenesis of many different human diseases. Although the enzymes involved with miRNA expression have long been thought to be well-defined, new work points to the existence of multiple non-canonical pathways for miRNA biogenesis. Our recent analysis has also shown that miRNA expression is frequently, globally suppressed in tumor cells compared with normal tissue. Furthermore, enzyme knockouts (KO) within the miRNA canonical biogenesis pathway, such as with the enzyme Dicer, have shown significant numbers of miRNAs expressed outside traditional miRNA processing. However, no comprehensive catalog of enzyme dependencies has yet to be reported. This summer, through utilizing our in-house program, Fragment Finder, we have determined the expressions of all miRNAs and numerous other related small noncoding RNAs (sncRNAs) in normal HCT116 colon cancer cells as well as in HCT116 knockouts of all of the major canonical miRNA processing enzymes. Excitingly, we find several major subsets of miRNAs and related sncRNAs defined by shared miRNA processing enzyme dependencies. In short, our research will contribute to potentially offering new therapeutic targets and novel strategies for selectively altering specific miRNA subgroup expressions. *Mentors: Dr. Glen Borchert, Mr. Noel Godang, Ms. Anita Nguyen, University of South Alabama.*

Computational Toxicology of TCE Metabolites: Using Molecular Docking to Assess Environmental Neurotoxic Risks

Alex Nguyen

Trichloroethylene (TCE), an industrial solvent and environmental contaminant, has been epidemiologically associated with increased Parkinson's disease (PD) risk; however, the molecular mechanisms underlying its neurotoxicity remain unclear. This study used molecular docking to predict interactions between TCE, its oxidative and conjugative metabolites, and proteins involved in neuroinflammation, oxidative stress, and PD pathogenesis. In Phase 1, AutoDock Vina was used to screen TCE metabolites (TCOH, TCA, DCA, CH, DCVG, DCVC, DCVC-sulfone, DCVC-sulfoxide, and NAc-DCVC) against inflammation-related (TLRs, CD14, TNF receptors), oxidative stress-related (COX-2, 5-LOX, iNOS), and PD-linked (LRRK2 kinase) target proteins. Significant binding affinities (< -6.0 kcal/mol) were validated by re-docking 10 times per proteinligand complex (RMSD < 2.0 ˚A). Phase 2 prioritized the strongest ligands from Phase 1, comparing them with established neurotoxicants (paraquat, rotenone, MPTP). DCVG and DCVC-sulfone showed binding profiles resembling rotenone but with overall lower binding affinities and greater affinities toward neuroinflammatory targets (COX-2, 5-LOX). Although TCE metabolites demonstrated weak affinity for α-synuclein, TCE itself moderately bound α-synuclein (-6.7 kcal/mol), suggesting potential synergistic neurotoxic interactions. These findings highlight TCE metabolites as targets for experimental validation, providing an inexpensive computational foundation for future research into environmentally driven PD. *Mentor: Mr. Grey Gaillard.*

Conjugation of an NAD-like Species with Glyceraldehyde 3-Phosphate Dehydrogenase

Liana Jayasana

Glyceraldehyde-3-phosphate dehydrogenase (GAPDH) is a key glycolytic enzyme whose catalytic activity depends on the reactive cysteine residue Cys142. This study examines the conjugation of 4-oxo-NAD (4NADO), an NAD analog, on GAPDH using MALDI-ToF mass spectrometry. GAPDH samples were incubated with glyceraldehyde 3-phosphate (G3P) and 4NADO, and mass shifts were recorded to detect adduct formation. The results demonstrated a mass increase consistent with the addition of 4NADO to GAPDH, supporting the hypothesis that 4NADO modifies Cys142, thereby blocking active site access and inhibiting enzyme function. These findings give clear evidence for an alternative form of GAPDH inhibition, which has effects on glycolytic control. *Mentors: Mr. Brandon English, Dr. Marie Migaud, University of South Alabama*

Designing, Implementing, and Evaluating a Free ACT Prep Program for Alabama Students

Clyde Davis, Logan Ives, Julia Schwartz, Jude Wheelock, Novita Whillock

Students and employees at the Alabama School of Mathematics and Science observed that Alabama high school students have historically underperformed on the ACT exam when compared to results from students residing in most other states. This disparity has increased in most years since Covid and has impeded the ability of Alabama students to compete with peers from other regions. Studies correlate high ACT scores with improved college admissions outcomes and scholarship earnings. So, over two years, an ASMS research team developed and implemented a free ACT prep program to ensure help and access for underserved students from all Alabama counties. In the process, the team followed a methodical plan of outreach and content delivery, including online, in-person, synchronous, and asynchronous approaches. The team is currently awaiting test results from the statewide March 2025 ACT so that they can measure program effectiveness. They hope to partner with the Alabama State Department of Education to secure modest funding for improving the program based on the processed data. *Mentor: Dr. Mitch Frye.*

Designing RNAi pesticides to specifically target invasive species

Madeline Borchert

Fire ants cause billions of dollars of economic damage every year, and common control methods kill all insects in a given area, even advantageous ones. As my local community is highly effected by fire ant damage, I wanted to design a pesticide that could help address this issue. I hypothesized that there are sequences that can be targeted to generate a RNAi pesticide that will specifically kill fire ants but not any other organism. I began this by conducting a literature review to identify ~20 genes likely to prove lethal if knocked down by RNAi in adult ants then identified regions of these bearing low similarity to other species. In all, candidate sequences were identified in four distinct genes, and I designed RNAi molecules to target these. Fire ants and carpenter ants were collected, treated with distinct RNAi molecules, and survival recorded over the next seven days. I found that RNAi molecules targeting these essential genes were each independently capable of decreasing fire ant survival, but only one (a RNAi targeting the RPPO gene) did not affect closely related carpenter ant survival. In conclusion, my findings support my hypothesis that there are sequences that can be targeted to generate a RNAi pesticide that will specifically kill fire ants but no other organisms. Invasive species are a huge issue in our environment, and the control technique created in this project potentially represents a viable method for extermination of invasive insects without harming important native species. *Mentor: Dr. Jeffery Demeis, University of South Alabama.*

Developing a Computational Method to Analyze the Effect of Testosterone on the Gene Expression of Blood Mononuclear Cells

Kingston Barnes

The goal of this project is to develop a bioinformatics tool to analyze the effect that testosterone treatments have on gene expression in blood mononuclear cells (mainly monocytes). We understand the effect that lipopolysaccharide (LPS) treatment has on the gene expression of monocytes, but the effect of testosterone is poorly understood. To achieve this, we have single-cell RNA (scRNA) sequencing data from monocytes treated in 4 different ways. LPS(-)TEST(-), LPS(-)TEST(+), LPS(+)TEST(-), and LPS(+)TEST(+). Using the scRNA data from these different treatment profiles, we can compare them to determine how gene expression changes. Because we know how LPS changes gene expression, we should be able to use the change from LPS(-) to LPS(+) with TEST(-) and compare that to the change from LPS(-) to LPS(+) with TEST(+) to find the change that TEST(-) to TEST(+) has on gene expression. The goal of this research project is to develop a computational method capable of making this analysis and finding the effects of testosterone on gene expression in blood mononuclear cells. *Mentors: Mr. Samiul Alam, Dr. Jingshan Huang, University of South Alabama; Dr. Guoyu Ling, Saint Louis University.*

An Eddy Current Braking System for Electric Sail Deployments

Ella Brochu

Space debris, which refers to decommissioned human-made objects in space in Earth's orbit, poses a threat to the sustainability of space exploration and utilization. Specifically, it threatens operational satellites, spacecrafts, and future space missions. As a result, many space debris capture and removal methods have been proposed in the last decade with many different approaches, from capturing debris using mechanical arms to capturing it with a casting net. However, the main problem that arises in such mechanisms is the deployment of the tether system in the early stages of the mission. The tether deployment process is complicated and causes unwanted vibrations throughout the tether. These unwanted vibrations in the tether can lead to the kinetic energy being used to separate different parts of the satellite and ultimately cause the satellite to fail. This paper seeks to solve this problem through the implementation of an eddy-current braking system, which slows or stops the tether through the friction between the magnetic fields of the electromagnet and the magnets. The proposed system uses an electromagnet that is turned on and off at varying distances in order to test the effectiveness of using an eddy-

current brake in order to mitigate any problems that would arise in the tether deployment process of space debris removal satellites. *Mentor: Dr. Carlos Montalvo, University of South Alabama.*

The Effect of Language Erasure on Culture in Africa Town

Jenna Wood

For this project, I examined how language loss affected the community of Africa Town from its founding to the current time. My research included studying the effect of language loss on a variety of cultures from Native American tribes to African American communities through close readings of primary sources as well as a review of academic literature in linguistics and cultural studies. I found that the oppression of a community's language results in a loss of connection within the community as well as a disconnection from their history. I was inspired to begin this research through reading Zorah Neale Hurston's Barracoon, a record of her interviews with Cujo Lewis, one of the founders of Africa Town. I hope that this project can bring awareness to the debilitating effects of language suppression on affected communities. *Mentor: Dr. Elizabeth Jones.*

Explainable Predictive Modeling for Personalized Anterior Cruciate Ligament Reconstruction Classification

Grayson Kim

Anterior Cruciate Ligament (ACL) reconstruction is essential for athletes, yet current classification methods often lack interpretability and personalization. To address this, we propose an explainable predictive model using multi-modal gait analysis and patient characteristics. We collected gait data via inertial measurement unit (IMU) sensors placed on bilateral wrists, ankles, and sacrum during walking and jogging tasks, alongside patient-specific surveys covering demographics, injury details, and recovery duration. Using Phase Slope Index (PSI), we quantified inter-sensor relationships and trained classifiers achieving 96.37% accuracy. Model explanations via heatmaps and permutation importance revealed that paired body movements, particularly in jogging, are key to classification. Additionally, t-SNE visualization showed that model confidence strongly correlates with recovery duration, reinforcing the link between recovery time and normalized gait patterns. This personalized, explainable approach enhances rehabilitation strategies and informs return-to-sport decisions, improving patient outcomes. *Mentors: Dr. Jiaqi Gong, Xishi Zhu (PhD. Candidate), University of Alabama.*

Evaluating the Feasibility of Using Lasers for Wireless Power Transfer

Ben Le

This study explores the feasibility of transferring power via laser beams to solar panels for battery charging or other applications. Milli-Watt diode lasers with nominal 650 nm wavelength and typical 4 mm beam diameter were directed on an amorphous silicon 16 cm^2 solar panels, with the distance, number, and collimation of beams varied. This study shows the potential of using laser beams to transfer energy to distant panels and downstream electronics, such as lower-power battery charging in remote locations where wired transfer and conventional solar charging would be impractical (e.g., underground). *Mentor: Dr. Mark Byrne.*

Examining Access to Breast Cancer Care in South Alabama

Reagan Constantine, Kate VanDerHeyden

This study investigates potential disparities in access to breast cancer care among residents of Lower Alabama, examining how race, socioeconomic status, geographic distance from treatment centers, and age may impact access to care. Using data collected for the University of South Alabama's hospitals as well as patient polls we identified potential barriers to care. Preliminary results found that the greatest obstacles to patients included a lack of access to reliable transportation or privatized insurance. These findings underscore the need for targeted

interventions to reduce access barriers and promote equitable breast cancer care across Lower Alabama. *Mentor: Dr. Rachel Hunter, USA Women's and Children's Hospital*.

Domination in Maximal Outerplanar Graphs

YangHong Chi

In the world of mathematics, we search for efficiency. Due to continuous progress and expansion of mankind, we need what is optimal for us, reducing what is not necessary and using the resources to our advantage. In this research, the goal is to identify a small set S of vertices (or edges) within a graph such that every other vertex (or edge) in the graph is adjacent to at least one element of S. This set S is said to dominate the vertices (or edges) of the graph. By applying this to real world issues in computing, train and subway routing, and even space exploration, we can increase efficiency and optimize resource allocation. Due to the high complexity of the problem, our research focuses on maximum outerplanar graphs, aiming to identify patterns and formulate conjectures regarding identities, formulas, and bounds for these graphs. Upon proposing a conjecture, we begin testing it on graphs with different numbers of vertices. If it holds for a small set of cases, we then explore whether it could be true for all graphs. By writing mathematical proofs, we determine whether the conjecture holds, potentially leading to formulas that optimize problem solving. This process ultimately yields the identities and formulas we propose. *Mentor: Dr. Elena Pavelescu, University of South Alabama*.

Forgotten History: The Language of Descendants

Jayla Daughtry

Intersectionality is a term which was coined by writer and civil rights activist, Kimberlé Crenshaw. This idea focuses on the social characteristics of an individual, and how the interactions of their various sections connect with one other another to result in an individual's social experience including relationships, communal expectations, etc. Though coined in 1989, intersectionality as an issue has been expressed and explored by many black women since the nineteenth century. An early example is the "Ain't I a Woman" speech by Sojourner Truth where she calls for the American public to recognize black women as women, humanizing their existence which becomes blurred between the sections of gender and race. In my research, I explored how the complexity of the perception of black womanhood lies within the concepts or measures of intersectionality. I have concluded that these weights can be divided into the subgroups of social acceptance, social respectability, and social normality. *Mentor: Dr. Elizabeth Jones*.

The Growing Significance and Impact of Artificial Intelligence in Cybersecurity, Smart Home Technologies, 6G Networks, and Strategies for Attack and Defense: A Comprehensive Literature Review

Anush Minali, Zachary D. Nelson

This project explores the evolving use of artificial intelligence in cybersecurity by evaluating the mechanisms of defense in smart home technologies and 6G networks and by researching defense techniques found in published articles. Articles relating to the topic were evaluated and data obtained from various research was used to write a thorough literature review. This review aims to answer the question of which cybersecurity techniques, including AI techniques, would be best to implement to protect upcoming smart home technologies and 6G networks. It also intends to further the understanding of cybersecurity for readers. Alongside the review, an exhibit involving a simulation of a phishing attack against an unsuspecting victim is used to demonstrate how these attacks can occur at an elementary level and present an understanding of the ease of such attacks when done by professionals at a higher level. *Mentor: Mr. Grey Gaillard*.

The History and Evolution of the Use of Isometric Projection in Engineering and Architectural Drafting

Maura Walldorf

Drafting is an important technique of illustration used in engineering and architecture to produce scaled drawings of buildings or products. These drawings are the blueprints for bringing those subjects to life and may range from small sketches to large, complicated, computer-generated drafts. Isometric projection is a method in drafting that rose in the mid-19th century and is used to provide accurate 3-dimensional perspectives. Such techniques have significantly improved quality and efficiency within these fields. This research will focus on how drafting was conducted prior to these techniques and how it has since affected these methods and has evolved over time. Through collecting sources and comparing old and new drawings I have made connections between the different eras of drafting and how those have been reflected in architectural styles and construction. Furthermore, I aimed to consider historical trends and events that may have contributed to and influenced those developments. *Mentor: Mr. Orren Kickliter.*

The Innovation Divide: Can Small Businesses Survive in a Rapidly Advancing Technological Society?

Eshal Syed, Mekhi Williams

As technology rapidly advances, large corporations leverage digital innovation, automation, and data-driven supply chains to optimize efficiency, scale operations, and dominate markets. With access to vast financial resources, cutting-edge AI, and global logistics networks, these companies gain a significant competitive edge. Meanwhile, small businesses often struggle to keep pace due to limited funding, outdated infrastructure, and barriers to integrating new technologies. This growing innovation divide not only threatens their survival but also intensifies competition, making it harder for small businesses to sustain market share. This research explores how technological advancements disproportionately benefit large corporations while small businesses face increasing challenges in supply chain management, digital adaptation, and competition. Key survival strategies include adopting affordable digital tools, leveraging AI for inventory and logistics, utilizing e-commerce platforms, and forming collaborative supply chain networks. By addressing both obstacles and solutions, this study aims to highlight ways small businesses can remain competitive and thrive in an increasingly digital and highly competitive economy. *Mentor: Dr. Peter Simonson, University of South Alabama.*

The Impact of Lower Income on Adult Obesity

Arina Markina

This research examines the relationship between lower income levels and adult obesity across selected counties in Alabama, Kentucky, and Mississippi. By analyzing 14 years of medical data, this study aims to identify patterns and correlations that showcase how socioeconomic status influences obesity rates. The project utilizes comprehensive data collection and detailed analysis to explore potential contributing factors, such as access to nutritious food, healthcare availability, and lifestyle choices in economically disadvantaged communities. The findings of this research will contribute to a better understanding of the intersection between income inequality and public health, offering insights that could inform future policy and intervention strategies. *Mentor: Dr. Khandokar Mohammad Istiak, University of South Alabama.*

Investigation of Potential Variations to the YInMn Blue Family of Pigments

Anna Birk, Dorian McKerchar, Lucas Miller, Karighan Womack

Some pigment colors are challenging to achieve in terms of production and optimizing the processes used to produce these pigment colors will make more sustainable and safer products widely available. After weighing the

proper mass for each sample, it was ready to be fired in a microwave, then the color was observed. Using a L*a*b* colorimeter the exact data that correlates to the color was able to be collected and compared to the data of other compounds. Reduction of the compound has produced no significant or permanent change in the pigment's color. Doping the compound with varying metals has shown differences in the color. *Mentor: Dr. Matthew Davenport.*

Leveling Up Architecture: How Video Games Transform Architectural and Urban Design

Ria Amtha

Isometric projection is a method commonly used in technical drawings to visually represent 3-Dimimensional objects in 2-Dimensions. This technique is commonly used in fields such as architecture, urban planning, and video game design. Often, video game designers use this technique when working alongside architects to create virtual landscapes for their projects. In this research I investigated how this pre-established collaboration could be used to benefit both architects and urban planners, making city planning and building design more efficient. To understand this connection, I explored the relationships between architecture and video game design. Specifically, how the programs used to create building games are similar to architectural and urban design programs. These similarities show that video game design programs could be potentially modified to be used by architects and urban planners to make technical designing much more efficient. *Mentor: Mr. Orren Kickliter.*

Medtrack: Noninvasive Tracking of ADHD Medication in the Body Novel Synthetic Derivatives of Vitamin B3 and their mode of Action

Amna Hadi, Ruitong Jin, Lilly Nguyen, Davis Stephenson

An increasing number of people are diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) every year, this in turn will lead to a higher risk and a percentage of people addicted to ADHD stimulants, such as Adderall. Consequently, an increase in ADHD diagnoses has caused a worldwide Adderall shortage. MedTrack is the solution to these issues. MedTrack wearable technology uses Raman Spectroscopy to monitor in real-time concentrations of Adderall in a person's body. In conjunction with a phone app, MedTrack will alert patients when Adderall levels are low and provide alternate non-stimulant methods to manage ADHD symptoms. The real-time tracking will also improve dosing for patients based on their activity levels and provide data for physicians to better manage an individual's long-term health. With a focus on addiction and drug management, MedTrack will revolutionize and individualize ADHD treatment. *Mentor: Dr. Elisa Rambo.*

Novel Synthetic Derivatives of Vitamin B3 and their mode of Action (ACS Project SEED Internship 2024)

Jordan Simmons

Nicotinamide adenine dinucleotide (NAD+) is a critical co-enzyme and is responsible for several cellular redox reactions, energy metabolism, oxidative phosphorylation, glycolysis and other major cellular events. Nicotinamide (NAM) and nicotinic acid (collectively referred to as Vitamin-B3) are the precursors of NAD+. Vitamin-B3 can be obtained from food sources (tryptophan), dietary supplements (NR, NMN, etc,.) or alternatively it can be revived from the salvage pathway that uses NAM. While studies showed that increased intake of NAD+ could ameliorate the diseased conditions in patients and older adults, the metabolites arising from the overdose of NAM can lead to cardiovascular diseases (CVD) and renal dysfunction. Inside the cells, excess NAM can degrade to Me-NAM that leads to the production of Me-2-PY, Me-4-PY and Me-6-PY. In the present work, we synthesized these metabolites (Me-2-PY and Me-6-PY) by Fenton reaction on Me-NAM and observed that Me-6-PY is formed as the major product relative to Me-2-PY. We used the similar reaction conditions for methyl-nicotinic acid (trigonelline), N-methyl-nicotinuric acid and di-N-Me-NAM-substituted putrescine derivatives to generate the oxidized species, in an effort to demonstrate the formation of oxidized species in an intracellular or extracellular oxidative

environment. We hypothesize that these charged species ought to behave as antioxidants and react with reactive oxygen species (ROS) and thus protect cells against oxidative damage. To validate this, we tested these derivatives on HepG3 (immortalized human hepatocarcinoma) cell lines and evaluated these pyridinium derivatives ability to quench ROS produced under reductive stress by NRH treatment in these cells and protect cells' viability. *Mentor: Dr. Marie Migaud, Mitchell Cancer Institute, University of South Alabama.*

Novel Method for Disposal of Orbital Debris

Aiden Ray

As orbital debris begins to occupy more and more of Earth's exosphere, deployment of artificial satellites and other spacecraft becomes increasingly treacherous. While modern collection devices– such as the robotic arms that astronauts commonly use to grab trash piece by piece– can slowly but surely gather larger objects in orbit, they are inefficient and unable to gather 70% of the remaining pieces of debris, which are too small to locate with modern tracking methods. The satellite invented in this project is designed to collect debris without necessarily knowing where said debris is located beforehand by using small projectiles that can adhere to any trash it collides with. These projectiles, which are electrically charged, can then be magnetically pulled towards a magnetic field, bringing any objects it is attached to along with it. Ultimately, we found that while the concept is feasible, many wires and a strong current would be necessary in order to create a strong enough magnetic force to recollect the pellets. However, the extremity of these components can be minimized by having the satellite approach the pellet, as magnetic field strength increases as it gets closer to the point it is exerting the field on. Overall, the idea is feasible in theory, but trial runs are needed to confirm this. *Mentors: Dr. Jessica Alexander, Dr. Mark Byrne.*

Old Plateau Cemetery and Africatown a History in Memorial

James Lott, Alexandria Sheffield, Ashley Thomas

Our research explores the history of the Old Plateau Cemetery and how it relates to the history of Africatown from the Reconstruction Era to modern times. Using research on the cemetery and graves, our poster will examine historical figures, trends and events of Africatown and collaborate it with the evidence from our research of the Old Plateau Cemetery. Subjects will span from the founders of Africatown and their contributions to Industrialization and its effects. *Mentor: CPT Derek Barry.*

The Other Perspective: Exploring the Influence of Social-Cultural Factors on the Perspective of Isometric Shapes

Katie Segars

Isometric projection is a way to represent 3-dimensional concepts in a 2-dimensional representative model without sacrificing accurate dimensions to perspective. This study aimed to determine how social-cultural factors frame a person's perception of a piece of media (art, technical drawings, film, etc.) in isometric projection compared to its intended interpretation in a standard 3-dimensional model. This project looked at articles comparing traditional 3-dimensional models to models from an isometric or orthographic perspective. We can then see that when you take away perspective, one has to interpret more information based on their foreknowledge since there is a lack of surrounding features to understand the stimuli we receive. In turn, this will allow more creative interpretations of different works that might not be true to what the creator originally intended. *Mentor: Mr. Orren Kickliter.*

Predicting Drug Candidate Success for Specific Protein Targets Using AI-Driven Analysis of Structural and Functional Characteristics

Makayla Woods

Clinical trial failures are a common occurrence in the complicated and expensive process of drug discovery. By investigating artificial intelligence's capacity to forecast drug candidate success, this study addresses this problem. The fundamental idea is to examine the complex interaction between proteins and ligands using machine learning. The study looks at functional data and structural elements in order to create predictive models. After then, these models might evaluate novel drug candidates, which could expedite the early phases of drug development and provide a more effective route to novel medications. *Mentors: Mr. Grey Gaillard; Dr. Sixue Zhang, Southern Research.*

Quantum Theory Prediction of Anionic Metal-Oxide Catalyst Efficiency for Methane-to-Methanol Conversion

Daniel Pacheco

The exploitation and conversion of methane to methanol has been one of the most challenging tasks in modern chemistry. Methane is found in vast quantities in oil wells and fracking sites but is usually burned due to the expense of its utilization. The on-site conversion to liquid methanol, though, would allow easy transportation and generation of fuel and feedstock for the industrial production of commodities. Previous cationic catalysts have been used to activate the C-H bond of methane, but they also tend to activate the weaker C-H bond of the methanol, leading to over-oxidized byproducts, such as formaldehyde. That said, I hypothesized that an anionic metal-oxide catalyst would interact weakly with the methanol, quickly separating the produced methanol from the catalyst and thus preventing the creation of byproducts. In light of this, I designed the anionic metal-oxide catalyst with the proper ligand to stabilize the negative charge on the metal center using density functional theory and Gaussian 16. I also identified the intermediate and transition state structures of the catalytic cycle for different spin states of copper, nickel, and cobalt, followed by chemical kinetic studies to estimate the efficiencies of the catalysts. Outcomes showed that the copper doublet outperformed other metals, avoided the release of methyl radicals, and reacted strongly with methane rather than the produced methanol. Changes such as lowering the intermediate-to-reactant reverse reaction rate and exploring the effects of certain solutes could increase both the efficiency of the conversion and the selectivity for methanol in future computational endeavors. *Mentors: Mr. Kevin Dolbeare; Dr. Evangelos Miliordos, Auburn University.*

Statistical Analysis & Prediction of the 2024 Presidential Election

Fatima Imran, Averionna Sierras

The purpose of this research project was to predict the outcome of the 2024 US election based off of quantitative data like the number of votes cast to a particular party in one state, and qualitive data like the socioeconomic reasoning as to why such would occur. With the compiling of previous election data sets and statistical projections, this project took a special interest in how differing states conduct their voting, the democratic party they belonged to, and estimates of how a "swing" state may lean in regard to data trends. This research predicts that the Republican party will win the 2024 presidential election via a majority vote by the states. Additionally, we aim to generally inform others about how the United States election system works and how this forms a unique relationship with the country's citizens. *Mentor: Mr. Nazrullah Aziz.*

Subversion or Enforcement? The Victorian Sensation Novel and its Relationship with Gender

Brooke Andrews, Adelaide Deputy

Victorian sensation fiction is a genre that started many of the genres of literature we know today such as horror and queer literature. It is filled with a constant tension caused by deceit, scandals, and crimes. The unusual and untraditional portrayals of different problems, characters, masculinity, and femininity for the nineteenth century entice and hook audiences'. Our research project focuses on three well-known sensation novels to analyze whether they subvert or reinforce societal and gender expectations of the nineteenth century. The novels we are researching are Wilkie Collins's The Woman in White (1860), Mary Elizabeth Braddon's Lady Audley's Secret (1862). After reading each book, our group and mentor would evaluate and discuss the characters' personalities and overall plot in depth. We then started to read in between the lines of the texts and formed opinions based on the characters body language, personality, and speech. From these observations we compared the conforming characters to the non-conforming characters and concluded that our novels both support, yet defy societal normality of the time period. *Mentor: Mr. Daniel Commander.*

Tooth or Tool: Differentiating Bone Surface Modifications on Late Pleistocene Vertebrate Fossils from Northern Florida

John Wilhite

These Late Pleistocene (11,400 ybp) fossils from northern Florida represent the remains of a diverse faunal assemblage. A percentage of these fossils bear markings which cannot be explained by taphonomic processes and may represent evidence of butchering by humans, animal predation, or scavenging. To determine the identity of these markings, the fossils were first identified via comparison with existing osteological data. Several taxa were identified, including alligator, deer, mastodon, and horse. For most taxa, at least one fossil bore signs of bone surface modifications (BSM). Identified BSM's were compared with those previously described from animal remains found at similarly aged archaeological sites and BSM's created via experimental studies under low magnification (<40x). When taken in combination, this data supports the conclusion that the remains described here likely represent discarded elements of animals hunted by some of the earliest human inhabitants of northern Florida. Furthermore, given the frequency of white-tailed deer in this assemblage and the high proportion of deer remains that show signs of butchery, these animals may have represented a significant dietary element for the indigenous people of northern Florida during the late Pleistocene. *Mentor: Dr. Andrew Gentry.*

TOM22 Expression in Breast Cancer: A Potential Biomarker for Tumor Diagnosis and Prognosis

Dorian Gonzalez Aguirre, Angel Torres-Maldonado, Hector Whiston, Olivia Yoo

TOM22 (Translocase of Outer Mitochondrial Membrane 22) is a key protein involved in the TOM complex. It plays a critical role in the proper functioning of the mitochondria. TOM22 acts as a receptor protein and facilitates the transfer of precursor mitochondrial proteins (synthesized in the cytoplasm) to the mitochondrion. In many cancers, including breast cancer, TOM22 expression is upregulated. This overexpression is due to the high-level metabolic activity of cancerous cells. Therefore, TOM22 is a detectable biomarker for tumor cells. To see this overexpression, we can use immunohistochemistry (IHC) as a staining method. By using antibodies specific to TOM22, we can visualize the difference between healthy and tumorous cells through a microscope. By staining multiple sets of breast cancer cells, we can not only diagnose cancer but also find correlations or distinctions between different ethnic groups and ages. *Mentor: Dr. Santantu Dasgupta, Mitchell Cancer Institute, University of South Alabama.*

Using a Gyroid Infill Structure to Improve Heat Transfer in a Reactor

Stephen Chen, John William Duffy

Using Fusion 360 modeling software we created a heat transfer loop in BWR nuclear reactor. Then implementing a gyroid infill structure into the loop, we tested whether there was a greater transfer of heat to the flow rate of water through the infill structure than a normal BWR reactor. *Mentor: Dr. Jessica Alexander*.

Unraveling PARG Inhibition through Structural and Biochemical Characterization

Kahyeon Jeon

Poly-(ADP-ribose) glycohydrolase (PARG) is a critical enzyme in the DNA damage response, responsible for hydrolyzing poly-(ADP-ribose) (PAR) chains and thereby regulating poly-(ADP-ribose) polymerase (PARP)-mediated DNA repair pathways. Given its essential role in genome stability and its emerging potential as a therapeutic target, structural insights into PARG-inhibitor interactions could facilitate the development of novel anti-cancer agents. This study aims to purify and crystallize PARG in complex with various inhibitors to elucidate their binding mechanisms and therapeutic potential. To achieve high-yield, soluble expression of PARG, we optimized bacterial expression in E. coli Rosetta 2 (DE3) cells by co-expressing molecular chaperones DnaK, DnaJ, and GrpE. Following cell lysis via sonication, PARG was purified using a sequential workflow comprising immobilized metal affinity chromatography (IMAC), reverse IMAC, and size exclusion chromatography (SEC), yielding protein of ≥ 95% purity. The purified PARG was concentrated to 2–10 mg/mL, flash-frozen in liquid nitrogen, and stored at -80°C for subsequent crystallization trials. Crystallization was initiated using commercially available screening kits, and initial crystal "hits" were subjected to systematic optimization to enhance crystal size and diffraction quality. Crystal screening was performed using a Bruker D8 Quest X-ray diffractometer to assess diffraction potential. Optimized crystals will undergo soaking with structurally diverse PARG inhibitors, enabling co-crystallization studies aimed at delineating inhibitor binding sites and mechanisms of action. The anticipated outcome of this study is a high-resolution structural model of PARG in complex with various inhibitors, providing critical insights into its enzymatic regulation and potential druggable sites. These findings will contribute to the rational design of PARG-targeted therapies, particularly in the context of cancer treatment, where PARG inhibition has been proposed as a strategy to enhance the efficacy of DNA-damaging chemotherapeutics. *Mentors: Saku Cu, Dr. Marlo Thompson, Mark Eggers, Dr. Ash Prakash, Mitchell Cancer Institute, University of South Alabama.*