16th ANNUAL CNAS UNDERGRADUATE SYMPOSIUM

THURSDAY, APRIL 24, 2025

12:00 PM – 4:30 PM

PLASTER STUDENT UNION

STUDENT POSTERS DISPLAY

1:45 PM to 3:15 PM

PSU Ballroom West

CNAS RESEARCH IN:

SCIENCE

TECHNOLOGY

ENGINEERING

MATHEMATICS

SPEAKER & AWARDS:

3:30 – 4:30 PM

PSU Ballroom East

SPEAKER:

Dr. Tayo Obafemi-Ajayi

Cooperative Engineering Program

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CNAS *Administration*

Jorge Rebaza, Interim Dean

Kyoungtae Kim, Biology Department Head

Adam Wanekaya, Chemistry & Biochemistry Department Head

Ajay Katangur, Computer Science Department Head

Theresa Odun-Ayo, Cooperative Engineering Program Director

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Guest Speaker Dr. Tayo Obafemi-Ajayi is the 2024 recipient of the Atwood Research and Teaching Award and an Associate Professor in the Cooperative Engineering Program

AI in Scientific Research - Ask the Right Questions: Define the Right Problems

Abstract: Science has rapidly advanced over the past few decades. With this advancement comes the realization that many remaining and emerging problems are increasingly complex. Solutions to these challenges require defining new problems that can be realistically addressed. The definition of these new problems can only come about through an approach that engages teams of researchers possessing diverse perspectives, so that all important aspects of the problem are captured in its definition. The path to effectively dealing with these problems starts with reframing their problem definition by asking the right questions. Defining these problems can rarely be done through a single disciplinary perspective by an individual researcher. Recent advances in artificial intelligence (AI) now permit it to help in properly defining a problem by tapping into more knowledge sources and perspectives than a single individual could ever bring to bear. We demonstrate the use of AI as a tool to tap into a vast amount of knowledge, integrating and synthesizing these sources for defining new problems that can provide solutions for the very complex scientific and societal problems that we face.

About Dr. Tayo Obafemi-Ajayi: Her research is interdisciplinary – overlapping engineering and computer science. She develops machine learning/artificial intelligence algorithms for broad utility in biomedical applications. Over the past seven years she has published a book, one book chapter and 13 peer reviewed international publications, and 29 peer reviewed international conference proceedings. In addition to her high-quality teaching in electrical engineering – she has mentored 70 under-represented ethnic minority students as National Science Foundation Louis Stokes Alliance for Minority Participation (LSAMP) research scholars. These scholars have done research throughout the disciplines within CNAS. Student feedback indicates that Tayo "genuinely cares about her students" and "very enthusiastic about teaching and learning".

About the Atwood Research and Teaching Award: The Atwood Research and Teaching Award was endowed by Dr. Jerry Atwood, a 1964 graduate of Missouri State University and now an internationally known chemist. He started his career at University of Alabama in 1967 but has been the department head at University of Missouri-Columbia since 1994. In addition, he was appointed a Curators Professor starting in 1999. The award winner receives a certificate and $2,500 to be spent over the next year on students, research supplies, summer salary or travel.

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6		**REGULATION OF EXPRESSION OF PAIN PATHWAY PROTEINS IN PRIMARY CULTURES OF RAT TRIGEMINAL GANGLION NEURONS AND GLIA IN RESPONSE TO GRAPE SEED EXTRACT AND CALCITONIN GENE-RELATED PEPTIDE** Ania Kovacs, Nicole Nalley, Biology Department. Faculty advisor: Paul Durham
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#1 THE STIMULATORY EFFECTS OF CGRP ON INOS AND P-P38 EXPRESSION IN PRIMARY CULTURES OF RAT TRIGEMINAL GANGLION NEURONS AND GLIA ARE NOT SUPPRESSED BY A POLYPHENOL-ENRICHED GRAPE SEED EXTRACT

Alyssa DeWeese, Nicole Nalley, Biology Department. Faculty advisor: Paul Durham

Elevated levels of the neuropeptide calcitonin gene-related peptide (CGRP) are implicated in the pathology of migraine and Temporomandibular Joint Disorder (TMD), which are prevalent orofacial pain conditions. We have previously shown that a polyphenol enriched grape seed extract (GSE) suppresses CGRP levels in preclinical models of migraine and TMD. CGRP activates a Gs-protein coupled pathway while GSE activates a Gi-coupled pathway. The goal of this study was to determine if GSE could inhibit the stimulatory effect of CGRP on expression of the pro-inflammatory proteins iNOS and P-p38 in mixed cultures of trigeminal ganglion. Cryopreserved trigeminal ganglia from neonatal Sprague-Dawley rats were used for establishing primary mixed cultures and changes in protein expression determined by immunocytochemistry. CGRP stimulated expression of P-p38 in Ad and C-fiber neurons. Incubation of cells overnight with GSE did not suppress the stimulatory effect of CGRP on P-p38 in either neuronal cell type. A similar pattern was observed with expression of iNOS in which CGRP stimulated expression in Ad and C-fiber neurons and Schwann cells and GSE did not suppress expression. These data support the notion that CGRP can increase the expression of pro-inflammatory proteins via a pathway that is not inhibited by GSE. Funding: NCCIH AT012501.

#2 THE EFFECT OF GRAPE SEED EXTRACT ON GAD65/67 AND GABAA RECEPTORS DOES NOT INVOLVE ACTIVATION OF GABAB RECEPTORS EXPRESSED ON RAT TRIGEMINAL GANGLION NEURONS

Donovan Aardema Faigh, Nicole Nalley, Biology Department. Faculty advisor: Paul Durham

Migraine and Temporomandibular Joint Disorder (TMD) are chronic orofacial pain conditions that greatly reduce one's quality of life and involve activation of trigeminal ganglion Aδ and C-fiber neurons, satellite glia, and Schwann cells. We have discovered that dietary inclusion of a polyphenol-enriched grape seed extract (GSE) inhibits pain signaling in preclinical migraine and TMD models. The goal of my study was to investigate whether the effects of GSE on the enzymes responsible for synthesis of the inhibitory neurotransmitter GABA, GAD65/67, and GABAA receptor involves activation of GABAB1. Cryopreserved trigeminal ganglia cells from neonatal Sprague-Dawley rats were used to establish primary mixed neuron-glia cultures. Cells were left untreated (naïve), incubated overnight with GSE, or co-incubated with GSE and the GABAB receptor antagonist saclofen. Protein levels were determined by immunocytochemistry. GSE increased GAD65 expression in C-fiber and Schwann cells, GAD67 in all four cell types, and GABAA in Aδ neurons. Saclofen upregulated GAD65 expression in C-fibers and Schwann cells, but decreased GABAA expression in Aδ neurons. The findings that saclofen did not inhibit the stimulatory effects of GSE provide evidence that the stimulatory effects of GSE on GAD and GABAA expression are not mediated via activation of GABAB receptors. Funding: NCCIH AT012501.

#3 COMPARISON OF GENE EXPRESSION IN RAT TRIGEMINAL GANGLION AND PRIMARY CULTURES OF TRIGEMINAL GANGLION USING QPCR

Emma Goodwyn, Nicole Nalley, Biology Department. Faculty advisor: Paul Durham

Activation of the trigeminal ganglion (TG) nerves is implicated in migraine and Temporomandibular Joint Disorder (TMD) pathologies. Studying the molecular pathways involved in these pathologies is critical in identifying therapeutic targets. In my study, basal expression levels of housekeeping, GABAergic, CGRP, and anti-inflammatory pathway genes in adult Sprague-Dawley rat TGs and primary TG cell cultures were determined by qPCR. Isolated total RNA was used for cDNA synthesis then analyzed by qPCR. ΔCt values were normalized to GAPDH. For TG tissue, within the GABAergic pathways, GABAB2 and GABAB1 mRNA were most abundant. For the CGRP pathway, PKA and CGRP mRNA were most abundant. GLAST mRNA was most abundant within the anti-inflammatory nociceptive pathway. In cultured cells, GABAB1, GABAB2, PKA and CGRP mRNA levels were greatest, with similar levels to TG tissue for RAMP1 but higher iNOS levels. For anti-inflammatory genes in cultured cells, MKP-1 exhibited the greatest expression with GLAST, GLT-1, and glycine at lower levels. Expression of GABAergic and CGRP pathway genes were similar in cultured TG cells and TG tissue. These results provide the foundation for future studies investigating the effects of CGRP and grape seed extract on expression of these genes in primary TG cultures. Funding: NCCIH AT012501.

#4 THE STIMULATORY EFFECT OF GRAPE SEED EXTRACT INVOLVES ACTIVATION OF GABAB RECEPTORS EXPRESSED ON RAT TRIGEMINAL GANGLION NEURONS

Lauren Jackson, Nicole Nalley, Biology Department. Faculty advisor: Paul Durham

Migraine and Temporomandibular Joint Disorder (TMD) are chronic pain conditions that greatly reduce one's quality of life and involve activation of trigeminal ganglion neurons and glial cells. We have discovered that dietary inclusion of a polyphenol-enriched grape seed extract (GSE) inhibits pain signaling in preclinical migraine and TMD models. The goal of my study was to investigate whether the inhibitory effects of GSE are mediated by GABAB receptors, specifically GABAB1 and GABAB2, which are activated by the neurotransmitter GABA. Cryopreserved trigeminal ganglia cells from neonatal Sprague-Dawley rats were used to establish primary mixed neuron-glia cultures. Cells were left untreated (naive), treated overnight with GSE, or cotreated with GSE and the GABAB receptor antagonist saclofen. Changes in protein levels were determined using immunocytochemistry. GABAB1 receptor expression was increased in response to GSE in Aδ and C fiber neurons while GABAB2 expression was only increased in C fiber neurons. Interestingly, saclofen also caused an increase in GABAB1 expression in C fibers but caused a decrease in GABAB2 expression in C fibers. Significantly, saclofen cotreatment suppressed GSE-mediated increases in GABAB1 and GABAB2 to below naive levels. In conclusion, the stimulatory effects of GSE involve activation of the GABAB receptor. Funding: NCCIH AT012501.

#5 AMMONIUM AND PHOSPHONIUM CHITOSAN POLYELECTROLYTES FOR GENE DELIVERY.

D. Kim, A. Chand, E. Braun, N. Le, K. Kim. Biology. Faculty Advisor: R. Sedaghat-Herati.

Gene therapy has long been regarded as a promising treatment for various acquired or inherited diseases. The success of gene therapy is highly dependent on finding efficient and safe vectors for nucleic acid delivery. To develop secure, efficient, and biocompatible gene delivery vectors, chitosan derivatives (polymers) bearing phosphonium or ammonium side chains were synthesized via carbodiimide-mediated coupling reactions. Additionally, to improve water solubility, enhance cell permeability of chitosan-DNA polyplexes, and reduce their cytotoxicity, the above polymers have been modified with polyethylene glycol (PEG). Chemical characterization of chitosan derivatives was performed by ^{1}H NMR spectroscopy. The polymers demonstrated excellent cell viability compared to industry standards like polyethyleneimine (PEI), as evaluated by the XTT cell viability assay. The polymers could effectively bind and condense plasmid DNA (p-DNA) to form polyplexes at a weight ratio as low as 0.28:1 of polymer: p-DNA. The synthesis and characterization of these polymers and their interactions with nucleic acids, as well as transfection efficiency and trafficking routes, will be presented and discussed.

#6 REGULATION OF EXPRESSION OF PAIN PATHWAY PROTEINS IN PRIMARY CULTURES OF RAT TRIGEMINAL GANGLION NEURONS AND GLIA IN RESPONSE TO GRAPE SEED EXTRACT AND CALCITONIN GENE-RELATED PEPTIDE

Ania Kovacs, Nicole Nalley, Biology Department. Faculty advisor: Paul Durham

Elevated levels of calcitonin gene-related peptide (CGRP) are implicated in the pathology of migraine and Temporomandibular Joint Disorder (TMD), which are prevalent orofacial pain conditions. Dietary inclusion of a polyphenol-enriched grape seed extract (GSE) suppresses CGRP levels in preclinical models of migraine and TMD. Activation of trigeminal ganglion neurons and glial cells plays a central role in migraine and TMD pathology. The objective of this study was to determine the effect of GSE and CGRP on expression of the CGRP receptor subunit RAMP1 and GSE on the GABAB ligand-binding subunit GABAB1 in trigeminal ganglion cultures. Cryopreserved trigeminal ganglia from neonatal Sprague-Dawley rats were used for establishing primary cultures and immunocytochemistry to investigate protein levels. Expression of the CGRP receptor subunit RAMP1was downregulated in Aδ and C-fiber neurons following overnight incubation with GSE while a 2-hour incubation with CGRP stimulated RAMP1 in both neurons and glial cells. Overnight GSE incubation stimulated expression of GABAB1, which binds the inhibitory neurotransmitter GABA, in Aδ and C-fiber neurons and glial cells. In summary, CGRP stimulates expression of its receptor to promote neuronal and glial excitability while GSE suppresses trigeminal ganglion activation by downregulating CGRP expression and upregulating the inhibitory GABAB receptor. Funding: NCCIH AT012501.

#7 EFFECT OF TIRE WEAR PARTICLE 6PPD AND 6PPDQ ON HEPG2 LIVER CANCER CELL VIABILITY

Magdalena Singleton, Emma Braum. Cell and Molecular Biology. Faculty Advisor: Kyoungtae Kim

6PPD is a known particle derived from the protective layer covering car tires. When combined with the ozone of the atmosphere, 6PPD has the ability to change into its quinone form, 6PPDq. It's estimated that 1900 tons of 6PPDq is released each year by the United States. The acute toxicity of 6PPD and 6PPDq to aquatic organisms has been well studied, however, the impact of 6PPD and 6PPDq on humans and other mammals is not widely understood. Because of the high levels of pollution, it is important we understand the implications of both 6PPD and 6PPDq on a variety of organisms. In particular, our lab is interested in the impacts of 6PPD and 6PPDq on humans at the cellular level. Our study aims to understand the impact of 6PPD and 6PPDq on two different human cell lines, HeLa (Human ovarian cancer cell line), and HepG2 (Human liver cancer cell line) using colorimetric techniques such as XTT analysis.

#8 EPIGENETIC EFFECTS OF CANNIBIS ON DEVELOPMENT

Cory Meyers, Biology Department. Faculty Advisor: Paul Durham.

Cannabis is a commonly used drug recently legalized for medical and recreational use in many states. Pregnant women are beginning to use cannabis to alleviate symptoms such as nausea. Scientists are concerned about the harmful effects that this might have on the mother and child caused by epigenetic changes in gene expression. Epigenetics is an emerging research field focused on understanding adaptive changes in gene expression that don't involve mutations but are mediated by lifestyle choices and environment. I have conducted a PubMed and Google Scholar search for the following terms "medical marijuana", "epigenetics", and "development" from 2015 to 2021. Cannabis exposure has epigenetic effects on sperm, pregnancy, and future generations. For example, exposure to THC caused rat sperm DNA methylation changes in 621 genes involved in hippocampus, MAPK, and cancer pathways. These changes caused long-lasting changes to attention and a significant increase in habituation of locomotor activity in offspring. Also, prenatal THC exposure caused alterations in 2meH3K9 and 3meH3K4, leading to reduced dopamine D2 gene expression and increased sensitivity to opiates in offspring. In conclusion, there is a clear need for further epigenetic research in pregnant women to identify potential harmful effects associated with prenatal and perinatal cannabis use.

#9 INVESTIGATION OF CHANGES IN NOCICPETION AND PROTEIN EXPRESSION IN RAT SPINAL TRIGEMINAL NUCLEUS CAUSED BY MAXIMAL JAW OPENING: EVIDENCE OF SEXUAL DYSMORPHISM IN TMD MODEL

Mikayla Scharnhorst, Biology Department. Faculty Advisor: Paul Durham

Temporomandibular Joint Disorder (TMD) is a debilitating orofacial pain condition with higher prevalence in women. The goal of my study was to investigate changes in nociception and protein expression in the spinal trigeminal nucleus (STN) in a preclinical TMD model caused by a single, transient maximal jaw opening. Mechanical nociception was determined using von Frey filaments 1 and 14-days post jaw opening and brainstem tissue was collected from young adult male and female Sprague Dawley rats. Immunohistochemistry was used to determine changes in protein expression. Female, but not male, rats exhibited enhanced nociception on day 1 and 14 post jaw opening when compared to naive animals. On day 1 post jaw opening, the ion channel NMDA, which is activated by glutamate, was significantly elevated in female animals. On day 14 post jaw opening, expression of the pro-inflammatory protein P-p38 and GABAB1 receptor, which binds the inhibitory neurotransmitter GABA, were significantly increased in females. Expression of GAD65/67 as well as CGRP were significantly decreased in day 14 females. Our findings provide evidence of sexual dimorphism in a novel TMD model caused by a single, transient maximum jaw opening event in which only female animals experience prolonged trigeminal nociception. Funding: NIH R34DE033592.

#10 THE CYTOTOXIC EFFECTS OF 6PPD AND 6PPDQ

Curtis Witt. Cell and Molecular Biology. Faculty Advisor: Kyoungtae Kim

The purpose of this study is to test the toxic effects of environmental 6PPD and 6PPDQ on mammalian cell models. Hepa 1-6 murine liver cells were treated with 200, 100, 50, or 25 µM of 6PPD or 6PPDQ as an *in vitro* model for environmental exposure. Cell viability was measured using an XTT assay and compared to a non-treated control. The results show that both 6PPD and 6PPDQ cause a significant decrease in cell viability at 200 and 100 µM concentrations. This suggests that exposure to 6PPD and 6PPDQ, particularly at concentrations exceeding 50 µM, has cytotoxic effects on mammalian cells, and more research should be done to investigate its mechanisms of cytotoxicity.

#11 HUMAN LIVER CELLS INTERACTION WITH QUANTUM DOTS RESULT DESTRUCT ACTIN FIBERS AND REDUCE MOBILITY

Mileah Metcalf. Biology. Faculty Advisor: Dr. Kyoungtae Kim

Quantum dots (QDs) are a semiconductive nanomaterials with potential for biomedical applications. QDs can fluoresce in a range of colors and more recently have been used as potential drug delivery vehicles (DDV). A caveat to their biomedical applications is their cytotoxicity. To better understand their mechanism of toxicity, transformed human liver epithelial-2 cells (THLE-2) were treated with cadmium selenide zinc sulfide quantum dots (Cd/Se/ZnS). Upon treatment of QDs, THLE-2 cells exhibited a loss in their attachment spindles and drastic change in morphology. The protein F-actin, which is the main component of the attachment spindles, showed significant rearrangement when treated with QDs. To further verify that the QDs disrupt viability of THLE-2 cells an XTT assay was performed. At concentrations 100 nM and 150 nM there was a significant loss in cell viability. We concluded our study with a migration assay which confirmed QDs inhibit cell motility.

#12 SAMPLE TIMING DOES NOT AFFECT INVERTEBRATE COMMUNITY STRUCTURE IN HYPORHEIC SAMPLES FROM OZARK STREAMS

Connor Bruemmer. Wildlife/Fisheries Biology. Faculty Advisor: Deb Finn

Ozark streams are complex systems with high biodiversity. Diverse invertebrates that feed iconic stream animals like fish, birds and bats can live deep under the streambed gravels, in the hyporheic zone. Sampling hyporheic invertebrate communities is challenging and most often achieved by manually installing wells that are then pumped from a known depth. Here, we addressed the effects of variation in timing between well installation and sample collection. The study included 18 total wells, 24 samples, and 4 treatments (6 replicate samples per treatment). On Day 1, 12 wells were installed, with 6 sampled immediately (“Immediate1” treatment). All 12 were then left in the sediment for a week. On Day 7, all 12 existing wells were sampled (6 “Repeat” and 6 “Delayed”), with an additional 6 wells installed then sampled immediately (“Immediate2”). The combination of these 4 treatments allowed us to determine whether well installation is a disturbance, assess recovery of the community after a known pumping disturbance, and also control for natural changes in communities through time. Results indicate similar community structure among all treatments. We conclude that this sampling method is robust to variations in sample timing for characterizing invertebrate communities in the understudied hyporheic zone.

#13 *AZOLLA CAROLINIANA* IMPACTS ALGAE ABUNDANCE AND NITRATES IN LAKE SPRINGFIELD, MO

Anna Faust, Jaslyn Johnson, and Benjamin Cooper. Biology. Faculty Advisor: La Toya Kissoon-Charles

Azolla sp. are tropical to temperate floating aquatic ferns that prefer still, quiet waters of lakes and ponds. Two species, *A. microphylla* and *A. caroliniana,* are known to occur in Missouri. *Azolla* is best known for its symbiotic relationship with the nitrogen-fixing cyanobacteria, *Anabaena azollae*, which gives *Azolla* a competitive advantage in the form of nitrates in return for physical protection and mineral nutrients. *Azolla* can become problematic as it forms dense mats that block sunlight and gas exchange. *Azolla* releases stored, fixed nitrogen as it decomposes, leading to algal blooms. In fall 2020, we first observed *Azolla caroliniana* growing in a small, quiet area along the northern shoreline of Lake Springfield, Missouri. In fall 2023, we began surveying Lake Springfield every 1-3 months to monitor *A. caroliniana* abundance and its impacts on water quality. We analyzed water samples for algae abundance, nitrate, and phosphate. *A. caroliniana* appeared in August and peaked in abundance in November before going dormant in December. We found that algae abundance was higher and nitrate concentrations were lower when *A. caroliniana* was present than when it was absent. Our findings indicate that Lake Springfield aquatic vegetation might sequester nitrates while *A. caroliniana* promotes algae growth.

#14 COUNTRY VS. CITY PLANARIA: COMPARING ABUNDANCE IN RURAL AND URBAN OZARK STREAMS.

Sarah Guymon, Riley Talbert. Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles

Planaria are macroinvertebrate flatworms that can be found in Ozark streams. They have characteristic morphological traits and regenerative abilities, and their sensitivity to pollution makes them ideal bioindicators for toxicology thresholds. Distribution of planaria can differ between stream systems due to variations in water chemistry and substrate characteristics. Urban and agricultural runoff is detrimental to planaria abundance, but the connection between land use and planaria sub-habitat preferences is not well understood. We surveyed an urban and a rural stream to assess the impacts of different land use on planaria abundance. The watershed of the urban stream is dominated by medium to high intensity development while the rural stream is dominated by pasture and hay fields. We collected and counted planaria in riffles, pools, and runs of each stream. We also measured several stream characteristics, including dissolved oxygen, conductivity, pH, turbidity, flow, depth, and substrate size distribution. We hypothesized that the rural stream would have greater planaria abundance than the urban stream. Findings of this study will reveal potential impacts of land use activities on stream health.

#15 EXPOSURE TO VARYING TEMPERATURES INFLUENCES *AZOLLA* GROWTH

Jaslyn Johnson and Anna Faust. Biology. Faculty Advisor: La Toya Kissoon-Charles

Azolla, a small floating aquatic fern, exhibits varying growth rates and physiological responses to temperature. During mild winters, *Azolla* goes into dormancy and sinks to the bottom of the water. In the spring, fragments rise to the surface and resume growth asexually as temperatures increase. Previous studies reported that *Azolla* growth rates are lower in colder months and peak in warmer months. In experiment one, we placed *Azolla* in the dark at -5, 5, 0 and 20 °C for seven days. All plants were then placed under LED light at 20 °C for 14 days. In experiment two, we placed *Azolla* in the dark at -5, 5, 0 and 20 °C for 14 days. All plants were then placed under LED light at 20 °C for 21 days. We hypothesized that *Azolla* exposed to colder temperatures will produce lower biomass than those exposed to warmer temperatures. In experiment one, plants below 5 °C experienced 2-7 times decrease in biomass, while plants at 5 °C and 20 °C experienced a 3–5-times increase. In experiment two, plants at 0 and 5 °C experienced a 3-4 times increase in biomass. Longer exposure to cold and dark conditions allowed for increased growth.

#16 THE LARGE AND MEDIUM SIZED MAMMAL COMMUNITIES AT BULL SHOALS FIELD STATION

Kali Rouse. Biology. Faculty Advisor: Sean Maher

The Missouri State University Bull Shoals Field Station (BSFS) is located along Bull Shoals Lake in Taney County and made up of two distinct units. The first unit is located within the Drury-Mincy Conservation Area (DMCA) that is managed by MDC and allows for hunting and other recreation. The second unit is located in Cedar Creek MO, and has not been subject to widespread management and is not open to the public. Between these two units, it is unclear how the differences in management and access impact the mammal communities. Here we show that there is a consistent mammalian community within both units, although several species are detected at only one of the two units. Overall both sites are dominated by the presence of Odocoileus virginianus and Sciurus carolinensis. Spilogale interruptus and Urocyon cinereargenteus were detected at several sites at Cedar Creek. Furthermore, we detect Lynx rufus and Procyon lotor more frequently at Cedar Creek. Our dataset is consistent with other observations that mesocarnivores are negatively impacted by human activity, although we can not clearly identify this as the main cause.

#17 BERRY IMPORTANT POLLINATORS: ARTHROPOD VISITORS OF AMERICAN ELDERBERRY ACROSS CULTIVAR

Katelin Meek, James Bynum, Caleb O'Neal, Andrew Thomas, Avery Russell, and Jenny Burrow. Biology. Faculty Advisor: Avery Russell.

Conservation of native plants often depends on an understanding of their pollination ecology. Historically, American Elderberry (*Sambucus nigra* subsp. *canadensis*) has served as a food source and health aid for many indigenous groups in North America and has increasingly been developed as a specialty crop for the dietary supplement market. Although American Elderberry has been hypothesized to be animal pollinated, the identity and relative abundance of arthropod visitors to its flowers remain uncharacterized. In this study, we sought to identify arthropod visitors to elderberry flowers and how patterns of visitation differed among cultivars. A comprehensive assessment of arthropod visitors to elderberry flowers was conducted in southwest Missouri from May 28th - June 26th, 2024. Although arthropod identification is ongoing, we find that arthropod visitors are spread among 11 orders and >40 families, with the greatest family level diversity occurring in the Coleoptera (>15 families), Diptera (>11 families, and Hemiptera (>8 families). There were no significant differences among cultivars in terms of abundance or Shannon Diversity. Most arthropod visitors to flowers were likely incidental pollinators: 32.4% were predators and 25.8% were phytophagous. Our results indicate that arthropod visitation of elderberry is common, yet most visitors likely play little role in pollination.

#18 WATER SOURCE INFLUENCES STREAM MACROINVERTEBRATE COMMUNITIES OF THE TROPICAL HIGH ANDES

Brynn Kayhill. Ecology. Faculty Advisor: Deb Finn

High-elevation streams have heterogeneous water sources that influence biodiversity. The tropical high Andes have two major stream types: glacier-fed and groundwater-fed. Glacier-fed streams have much more dynamic flow and temperature patterns than groundwater-fed streams. Climate change is progressing rapidly in this region, causing concern about the vulnerability of the biodiversity in glacier-fed streams. We asked if spatial and temporal patterns of macroinvertebrate community structure varied consistently between the two stream types on two glaciated volcanoes in Ecuador. We quantitatively sampled macroinvertebrates on nine evenly distributed dates through a full year in five paired glacier-fed /groundwater-fed streams, with each of the 10 streams sampled at ~4000 meters asl. Groundwater streams had greater abundance and taxa richness than glacier-fed streams, and a multivariate analysis revealed consistent differences in community structure between the stream types. However, community structure had similar temporal stability in the two stream types. The unexpected community stability in physically dynamic glacier-fed streams could be due to morphological and life history adaptations to survive these harsh conditions. In this region of rapidly shrinking glaciers, the high diversity of groundwater-fed streams suggests they could provide climate-change refuge for a sizeable proportion of the high-elevation macroinvertebrate fauna.

#19 FOOL ME ONCE: SUCCESSFUL MIMICRY IN A CRYPTICALLY DIOECIOUS PLANT SPECIES DESPITE BEE LEARNING

Leo Carpenter, Oscar Peterson, Marco Russo, Christopher Martine, and Avery Russell.

Biology: Ecology, Wildlife and Conservation. Faculty Advisor: Avery Russell

Flowering plant species often manipulate pollinators via deception. Male and female flowers of dioecious plant species often look alike (cryptic), but quality of male vs female food rewards can differ substantially. We thus expect pollinators to leam to discriminate flower sex to avoid exploitation. Using lab-reared bumblebees, we assessed how a dieocious species with female flowers resembling males (but offering inferior rewards) manipulates pollinators and the role of bee experience in avoiding exploitation. We evaluated the role of anthers and pollen in maintaining deception. We found that with experience, female anthers reduced bee correct rejections but increased correct detections. Our results suggest that female anthers act as an advertisement, deceiving bees to visit female flowers. Inviable pollen offeredby females reduced correct decisions and thus could contribute to deception. Our results demonstrate that while bees can leam to avoid exploitation, learning was imperfect. As pollinators learned to avoid female flowers, they accidentally avoided male flowers, therefore maintaining deception. Thus, successful mimicry in this dioecious species likely requires both anther and pollen to reduce bee learning success. Overall, female flowers effectively mimic males and that offering inviable pollen is an effective strategy that may ensure pollination for nectarless dioecious plant species.

#20 AVIAN RESIDENT ROUND UP: BIODIVERSITY COMPARISON OF JAMAICA'S SOUTH COAST

Josey McChesney, Kaitlyn Scarborough. Biology: Ecology, Wildlife and Conservation. Faculty Advisor: Dr. Alexander Wait

We traveled to the southern coast of Jamaica to collect data on avian biodiversity, specifically the species richness and types of birds present in two towns: Bluefields and Treasure Beach. We hypothesized that Bluefields would have more forest birds present because of its rainforest ecosystem, and Treasure Beach would have more shore birds because of its chaparral climate. We collected species data using Audio Recording Units (ARUs) in each location, capturing bird calls between the times of 400-900 and 1600-2100. The recordings were put through the BirdNET program to catalog the species present in each area. This list of birds was then separated into native and non-native, and we compared the preferred habitats and conservation status of the birds as found on the IUCN website. These data resulted in the conclusion that Bluefields had more forest birds present which supports the hypothesis stated, while Treasure Beach had more wetlands birds present which does not support the hypothesis, which could be explained by a large open pond and wetland area that attracts a high number of species.

#21 HEALTH AND BIODIVERSITY IN A JAMAICAN REEF INCLUDING STATUS OF INVASIVE LIONFISH

Jaycie Balkenbush and Jordan Porsch*. Wildlife and Fisheries Biology. Faculty Advisor: Alexander Wait

This observational study examined the purported declining health of Moore's and Calabash Bay reefs in Jamaica, including an assessment of the population of the invasive Lionfish (Pterois volitans). Photo and video documentation were used to document the health and species richness of the two different reefs. We used data from a previous report by Jaime Kohrs in 2024 to compare the health of Moore's reef. Current data shows a significant decline in general reef health and species richness. Previous data from Calabash Bay is not available, but species richness is much higher compared to Moore's (e.g., 70 vs. 25 fish species) and the reef is much healthier. Lionfish are known to negatively impact species richness. Local fishers report seeing a decrease in general fish populations when the Lionfish started to invade Moore's Reef, this may be a contributing factor to the lack of biodiversity of the area. However, the fishers in the area have taken steps to successfully combat the Lionfish population ("eat it to beat it"), but this may not ultimately result in reef system health increasing given other pressures. Ultimately, our data indicate Moore's Reef has had a decline in general health, especially in comparison to Calabash Bay.

*Authors contributed equally and are listed in alphabetic order.

#22 CONSEQUENCES OF ANTHER MORPHOLOGY FOR BEE POLLEN COLLECTION AND POLLEN TRANSFER.

Marco V. Russo, Mario Vallejo-Marin, Leo Carpenter. Biology. Faculty Advisor: Avery Rusell

Approximately 10% of plant species possess flowers with poricidal anthers, which dehisce (release pollen) via pores, valves, or slits at their tips. Poricidal anthers have independently evolved more than 200 times from non-poricidal ancestors that dehisce completely. Yet intermediate forms of anther dehiscence between complete and poricidal are rarely observed, suggesting that intermediate forms of dehiscence may be less functional in terms of pollination than either extreme. To understand how anther dehiscence affects pollen acquisition by bees and pollen transfer to flowers we performed a lab study using lab-reared bumble bees (*Bombus impatiens*) and greenhouse-grown bisexual flowers from *Solanum sisymbriifolium.* We examined a) how the completeness of dehiscence affects the amount and rate of pollen collection by bees and b) how the increasing completeness of dehiscence affects pollen transfer to each bee body part (not in the pollen baskets) and the flower stigma, as well as the amount of pollen left in the anthers after buzzing. Considering only benefits to the bee, poricidal dehiscence and nearly complete dehiscence increase pollen collection and pollen collection rate, relative to intermediate dehiscence. However, pollen counting to assess benefits to the plant are still in progress.

#23 WHY CAN'T WE ALL JUST SHARE? DRIVERS OF RESOURCE PARTITIONING IN BUMBLE BEE SPECIES ACROSS SOUTHWEST MISSOURI PRAIRIES

Ashley White, Tabitha Moul, Kendra Edge, Charlotte Davis, James Bynum, Kierstin Howard, Moth Castagna, Jenny Burrow, Leo Carpenter, Success Ekemezie, Avery Russell. Biology: Ecology, Wildlife, and Conservation. Faculty Advisor: Avery Russell.

Competition for resources can strongly affect the ecology of coexisting species. Generalist bumble bees forage on a wide variety of plant species and commonly compete for the same resources. Competition for resources may involve intraspecific or interspecific interactions. According to ecological theory, competitive pressure might be alleviated when individuals that would otherwise compete for the same resources instead specialize on different subsets of these resources, a phenomenon known as resource partitioning. Yet whether intraspecific and/or interspecific competition drives resource partitioning in bumble bees is unknown. We therefore investigated causes of resource partitioning for pollen as it is a primary source of protein in bumble bee populations across 12 Southwest Missouri prairies in 2023 and 2024. To accomplish this, we captured female bumblebees, identified them to species, collected the contents of their pollen baskets (corbiculae), and characterized the relative frequency of morphologically different pollen types via microscopy. We found that bumblebees engaged in resource partitioning, and that this was driven primarily by intraspecific competition, and potentially to a lesser extent by interspecific competition. Our results might suggest that effects of interspecific competition are limited when species richness is low (as appears to be the case for bumblebees on Southwest Missouri prairies).

#24 THE IMPACT OF KATYDID VOCALIZATIONS ON THE NATIVE BAT POPULATION

Asher Hutchinson. Biology. McDonald County HS.

Our study investigated the potential impact of biophony, specifically the vocalization of katydids and the impact they may have on the four native species of bats at Big Sugar Creek State park: *Lasiurus borealis, Myotis grisescens, Nycticeius humeralis,* and *Perimyotis subflavus*. We hypothesized katydid vocalizations to be interfering with the efficiency and use of the bats' echolocation; due to the katydid calls including frequencies that are within the ultrasonic range- the same as the bats chirps. This is potentially forcing the bats to change their foraging methods to accommodate for the interfering frequencies. In order to conduct our study we placed a Song Meter Mini Bat 2 AA, which recorded our place of study year long. Once the data was compiled we created a graph summarizing the data, to determine if the inclusion of katydids is truly affecting the bats' habits. Our results suggest that some bats are more affected than others by the addition of katydid vocalizations, although we do not know the specifics we hypothesize that this is due to the differences of their auditory bullaes.

#25 A STUDY OF WHITE OAK DECLINE IN THE OZARK PLATEAU.

Autumn Lutes. Biology. McDonald County High School.

White Oak Tree (*Quercus alba*.) mortality has been increasing in forested areas since it was first recorded in 2011. There has been growing concern over the long term stability of ecosystems containing these trees, as they have a great ecological impact on their areas. They are a keystone species as they provide shelter, food, and are important to the timber industry. This study took a qualitative survey of a ridgetop in Big Sugar Creek State Park of all the *Q. alba* found and imported those observations into TreeSnap. We used R and ArcGIS to analyze the data against soil types and hillslope. We found that tree density had the highest impact of mortality and morbidity among trees on a higher hillslope. Trees in Soil type A do not maintain the same density numbers as the other soil types, but still fit with the mortality/morbidity rates in the other soils. In soil type B tree mortality/morbidity increased as density and hillslope increased. Soil type C appears to be unsuitable for White Oak Trees.

#26 THE USE OF COST-EFFICIENT DRONES IN RESEARCH

Brady Bogart. Biology. McDonald County High School.

Drones are increasingly being used in scientific research to overcome challenges in data collection. While high-end drones can cost over $10,000, researchers have successfully utilized more affordable models for data gathering. This study explores the possibility of using inexpensive drones to collect data and information such as turtle populations in Indian Creek, Anderson, Missouri. By using a drone to conduct a study, the animals and environments can remain untouched and unaffected while allowing the operator to collect a large amount of data with minimal labor required. The drone produces a clear and quality image that can be easily studied. Other benefits include the ability to map out an area and mark specific coordinates using the drone. While there can be limitations such as battery life and sensitivity to weather, drones have proved to be an effective resource for visual surveys and habitat mapping. This allows for a cost-efficient alternative for research and can be used in other fields when there is a limited budget.

#27 NOISE POLLUTION ABSTRACT

Carli Watson and Clayton Hosier. Biology. McDonald County High School.

Studies have shown the negative impact of noise pollution on aquatic animals. For example, a study done by University of Melbourne found that noise pollution can alter whale migration patterns, leading to slower journeys or even migration failure. For this particular study we are focusing on crayfish, this is because crayfish play a vital role in the ecosystems of our rivers. This is because they filter organic material, break down decaying matter, and serve as food for other animals, thus contributing to overall water quality and food web health. This project consists of multiple tests that allow us to understand how noise pollution affects crayfish found in our local rivers. This experiment is important in order to understand the effects of noise pollution on wildlife such as creating stress, health issues, distribution of navigation, and habitat displacement.

#28 CHEMICAL ECOLOGY IN EPICUTICULAR WAX IN THE OZARK REGION

Jorja Westrick and Harley Collins. Biology. McDonald County High School.

Plants have a chemical trait that allows them to produce a wax on the outside of the cuticle. This is called *epicuticular wax,* which is found on every single plant globally, excluding marine plants. This wax provides water retainment, UV protection, insect deterrence/attraction, ect. Epicuticular wax is vigorously studied by agriculturalists for the purpose of enhancing crops. For example, making them less susceptible to common harmful bacterias or breeding plants that are more resistant to drought. Our survey however, observes the chemical patterns of hydrocarbons in epicuticular waxes on plants native to the Ozarks. With this information, future research projects can use this study as a reference to the chemical compounds of the plants included in our survey. By sampling twenty-four plants native to the Ozarks and six samples from Mississippi, we are able to compare the patterns in the chemical compounds of these plants. Using gas chromatography-mass spectrometry, Dr. Lucas Busta from the University of Minnesota, graphed out how much of each hydrocarbon was in each sample. These hydrocarbons include, alkanes, alcohols, fatty acids, and triterpenoids. Understanding epicuticular wax on native species is important for helping rebalance ecosystems, breeding resilient species, and understanding the environment around us.

#29 GROWTH RATE OF *FAXONIUS LONGIDIGITUS*

Daytona Martin. Biology. McDonald County High School.

Understanding the growth rate of *Faxonius longidigitus* is essential for assessing its life history strategies. Through controlled laboratory experiments, we measured growth rates based on changes in body size, weight, and length over a defined period of time. Environmental factors such as water temperature, food availability, and habitat conditions were closely monitored. Influenced by multiple ecological and environmental factors, these variables are important to know to find what affects the growth rate of long-pinchered crayfish.

#30 THE ABSENCE OF BD IN SALAMANDERS IN SOUTHWEST MISSOURI

Emerson Ruddick. Biology. McDonald County High School.

Batrachochytrium dendrobatidis (Bd) is a deadly fungus threatening amphibian populations. It infects the skin, leading to *chytridiomycosis.* Infected salamanders experience impaired breathing and a disturbance in their regulation of salt and water balance which can lead to death. Bd has been detected on every continent inhabited by amphibians including the state of Missouri. Although it has been found in Missouri, its distribution and impact on local salamander populations in Southwest Missouri, remains insufficiently characterized. Data was collected in Big Sugar Creek State Park in McDonald County, Missouri. Salamanders located under rocks and logs in moist hollows were captured and swabbed following SNAPS protocols. In 2024, 40 samples were taken from seven species, none tested positive for Bd. A similar study was done in 2023 with four different species and 32 samples taken, none tested positive for Bd. Given the endemicity of Bd, a 100% negative result was not expected. There are various reasons why this may have occurred, some ideas explored in this study include; salamanders being separated by microhabitats, Elk River Hills Natural Area's ecosystem health, Karst topography, weather/climate effects, and small population sample size.

#31 EVALUATING REFUGE TRAPS FOR SUSTAINABLE CRAYFISH MONITORING: EFFICACY AND CONSERVATION OUTCOMES.

Gia Coffel. Biology. McDonald County High School.

Understanding crayfish populations is critical for conservation efforts, particularly in regions where invasive species threaten native biodiversity. This study evaluates the effectiveness of habitat-based refuge traps in monitoring crayfish populations in Southwest Missouri. Traps were designed to mimic natural ecosystems; using large stones, gravel, and organic material to attract crayfish while minimizing environmental disruption. Results indicated that while both invasive and native species were captured, the distribution varied by trap design and habitat conditions. Native species such as the Ringed Crayfish (*Faxonius neglectus*), appeared more frequently, showing a lack of abnormality in Missouri's streamways and thriving in their structurally complex environment. Findings suggest that refuge traps are a sustainable and effective method for long-term crayfish monitoring, aiding conservation efforts by providing a low-impact technique for assessing species distribution and abundance. Future research should focus on optimizing trap designs for specific habitat conditions to improve monitoring accuracy.

#32 THE SEASONALITY AND MIGRATION OF BATS IN BIG SUGAR CREEK STATE PARK.

Mykinley Bice. Biology. McDonald County High School.

Bats are among the most threatened mammals in North America. Our objective was to investigate the seasonality of bat populations in Big Sugar Creek State Park, specifically to understand why certain months exhibit increased bat activity, and to enhance understanding of the migration patterns of these bats within the park. Our team deployed a Song Meter Mini Bat in Big Sugar Creek State Park from April 2024 to November 2024. Kaleidoscope Pro was then used to analyze and auto-id the bats. Data was organized into a line graph to show the number of calls weekly, alongside an analysis of the corresponding weather conditions. Historical data was obtained using wunderground.com then compared to the collected data. Some data was excluded due to Kaleidoscope Pro's limitations in classifying similar bat vocalizations. Notably, we observed a decrease in bat activity during periods of record high temperatures; however, a significant increase in activity was recorded as the Fall months approached. As temperatures slowly cooled, bat activity in Big Sugar Creek State Park began to decline again.

#33 GROSS PRIMARY PRODUCTION IN THE MISSISSIPPI AND ARKANSAS RIVERS

Shey Hemingway. Biology. McDonald County High School.

Understanding the balance between primary production and ecosystem respiration in freshwater systems is crucial for assessing nutrient transport and its downstream effects on coastal ecosystems. This study aimed to evaluate Gross Primary Production (GPP) and ecosystem respiration along the Arkansas and Mississippi Rivers using the light/dark bottle method. Dissolved oxygen measurements were taken from six locations, two in the Arkansas River and four in the Mississippi River, before and after a 24-hour incubation period. Results indicated higher levels of dissolved oxygen compared to respiration at all sites, suggesting potential method limitations or alternative processes for oxygen-producing, such as nitrifying bacteria. These findings show the complexity of freshwater productivity and its role in nutrient runoff, which can contribute to coastal dead zones and harmful algal blooms. Further research should refine sampling methods and explore microbial contributions to oxygen dynamics, improving our understanding of aquatic ecosystems health and its impact on economically valuable coastal ecosystems.

#34 GREEN SYNTHESIS OF PARA RED

Anaiya Murray. OTC Chemistry. Faculty Advisor: Patrick Casey

The purpose of this study was to determine a safer, greener way to produce azo dyes in the laboratory in a way that is safe for the environment and for those making it. The goal was to find a series of experiments that produces less waste and requires less reactants to get it going. The azo dye para red was produced from aniline using a string of experiments, starting from a sample of aniline. Through these, a slightly greener way of synthesizing para red was found, but it wasn't much better than the textbook method for making it. In the future, one could use the results found to continue to find safer ways to synthesis para red and other similar azo dyes.

#35 A GREENER SYNTHESIS FOR THE ORPHAN DRUG, DANTROLENE

Wade West, OTC Chemistry. Faculty Advisor: Patrick Casey

The purpose of my research was to try and synthesize an "orphan" drug, a pharmaceutical that is made rarely and is very expensive to have as a prescription. The target molecule was Dantrolene. The goal was to use greener methods and produce sufficient yield. Aniline was the starting point for the molecule and the synthesis progressed through five steps. Products were analyzed using melting points and IR spectroscopy. The first three steps work well and with yields being; 55.8% for the first, 68.4% for the second and 70.0% for the third step. However, the fourth step has proven to be an issue. The best results from running the fourth step were only 9% yield. The fifth step was not able to be tested. The fourth step has been creating an oil mixture instead of a solid product and we are unsure as to why it has appeared multiple times. If the fourth step can be corrected, a complete synthesis can be completed.

#36 PURIFICATION AND EXPRESSION OF THE CANINE ONCOPROTEIN, P53.

Samantha Ball and Zachary McCubbins, Chemistry and Biochemistry. Faculty Advisor: Natasha Devore

Canines offer a unique comparison as they live in the same environment as their owners and develop cancer on their own during old age. Canine oncoproteins also share approximately 80% amino acid identity and are found at similar rates in comparison to human cancers. The goal of this experiment was to purify the canine p53 protein and then use NMR to see changes to target DNA when protein is bound. The protein was expressed in LB broth, purified using nickel affinity chromatography and nickel gravity column. SDS-PAGE was used to determine success of purification. If successful, the concentrated protein was titrated into a short target strand of DNA. NMR experiments will utilize ^{31}P in the DNA strand to compare changes in the local DNA structure when bound to protein versus when the DNA is free in solution. The canine p53 gene was found to be purified successfully when the chromatography was completed in a cold environment and without gravity nickel column. Lots of protein is required for NMR experimentation. We are working to fully optimize purification to increase the yield.

#37 THE IMPACT OF THE E148L MUTATION ON THE FLUORESCENCE OF YELLOW THERMOSTABLE PROTEIN

M. Brill. Department of Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore.

YTP-E is a thermostable yellow protein that was mutated from the better known thermal green protein (TGP). In a concerted effort to increase the fluorescence of the protein while maintaining or improving the thermostability, the mutation E148L was introduced. Site-directed mutagenesis was performed PCR, followed by transformation into XL10-Gold Ultracompetent cells and three colonies were selected for sequencing to verify the plasmid was successfully introduced with desired mutation. This plasmid was then transformed into BL21 cells followed by outgrowth in 2 liters of LB media with induction of protein production by adding IPTG. After three days of growth, cells were harvested by centrifugation and resuspended in buffer. The cells were then lysed using a sonicator and centrifuged to remove any insoluble cell debris. YTP-E E148L was then purified using a nickel affinity column and NiNTA buffers. Once the purified protein was obtained, it was analyzed with the UV-vis and fluorescent spectrophotometer to determine quantum yield. YTP-E E148L was found to have little to no fluorescence with a quantum yield of 0.0009, an extreme drop from YTP-E at 0.03 ± 0.001. A crystallization tray was also prepared, but determination of three-dimensional structure was not pursued as crystals were very small.

#38 CHANGES IN STRESS, AMINO ACIDS, AND ANTIOXIDANTS LEVELS OF PEAS (*PISUM SATIVUM*) EXPOSED TO BIODEGRADABLE AND NON-BIODEGRADABLE MICROPLASTICS ON PEAS

Tyler Cobb, Blessing Akinwande, Mary Fakunle, Riley Pope, Jake Churchman, Collin Mourot, Wesley Jones, Minho Yoshimatsu, Chemistry and Biochemistry. Faculty Advisor: Cyren Rico

Microplastics are small plastic particles less than 5 millimeters in size. They form from the breakdown of larger plastic items like bottles, bags, and synthetic fabrics. Due to their small size, microplastics are easily carried by wind and water, and can easily accumulate in the environment. Biodegradable microplastics such as polylactic acid are widely used in agriculture because they are easily broken down into harmless substances by microorganisms. In contrast, non-biodegradable microplastics such as polyethylene are synthetic polymer plastics that do not degrade naturally through biological processes into harmless substances. In this study, we chose pea plants to do a short exposure cultivation under greenhouse conditions, dividing them into three groups: non-treated control, biodegradable microplastics-exposed, and non-biodegradable microplastics-exposed plants. We focused on analyzing the impact of biodegradable and non-biodegradable microplastics on the stress levels and amino acid and antioxidant concentrations. Results showed increasing trends in stress levels in plants exposed to biodegradable microplastics and were accompanied by alterations in antioxidant concentrations.

#39 CHLOROPHYLL AND ELEMENTAL CONTENTS OF SCALLIONS (*ALLIUM FISTULOSUM*) EXPOSED TO TIRE WEAR POLLUTANT (6-PPD)

Collin Mourot, Tylor Cobb, Brooke Winder, Katie Poage, Jamie Sencenbaugh, Emma Braun, Riley Pope, Mary Fakunle, Blessing Akinwande, Jacob Churchman, Wesley Jones. Chemistry and Biochemistry. Faculty Advisor: Cyren Rico

N-(1,3-dimethylbutyl)-N’-Phenyl-p-phenylenediamine (6-PPD) has been shown to have major health effects on humans which include reproductivity issues, a neurotoxic effect, and can damage heart tissues. The study focused on measuring the effects that a common chemical in tires (6-PPD) has on the development of scallions. We prepared 4 treatments each consisting of 4 replicates. The treatments were control, 5 ppm, 10 ppm, and 50 ppm of 6-PPD which were added to soil that was used to grow scallions. Chlorophyll and elemental composition of scallions were collected. Data seems to show a quite minimal effect on the plant’s chlorophyll content and elemental composition.

#40 EFFECTS OF PEPTIDE DELETION ON THERMOSTABLE GREEN PROTEIN ANALOG PERFORMANCE

Avery Elliott. Biochemistry and Chemistry. Faculty Advisor: Natasha DeVore

This study examined the effect of the deletion of proline residue 145 on TGP Q66E on excitation and emission wavelength, thermal and pH stability, quantum yield, structural prediction and optimization of the crystallography. Deletion of residue 145 from TGP Q66E was predicted by AlphaFold3 to result in a uninterrupted beta strand seven in the structure of TGP Q66E. In cyan versions of GFP, removing the gap in beta strand seven resulted in a substantial improvement in fluorescent brightness. We hypothesized that this adjustment may have similar results with the TGP derived proteins. Thermal stability, and pH stability were measured using Spectramax M5 after 1 hour, and crystallography was optimized using hanging drop vapor diffusion. The proline deletion displayed a significant decrease in quantum yield compared to TGP Q66E, thermal and pH stability remained similar, the excitation wavelength changed from 493nm to 474nm. Crystals were observed in two morphologies, octahedral and needle-like, with better diffraction characteristics for the needle morphology. Structural prediction showed connection of beta sheet, but due to issues modeling chromophore structure, further crystallization and diffraction is needed to determine the structural impact of proline residue removal on TGP.

#41 REPRESENTATIONAL DETERMINISM IN NUCLEOPHILIC ALIPHATIC SUBSTITUTION AND ELIMINATION REACTIONS

T. Howard. Willard High School. Faculty Advisor: Gautam Bhattacharyya (Chemistry and Biochemistry)

A substantial portion of organic chemistry courses is devoted to reactions, typically taught using a mechanistic approach. In the mechanistic approach, the electron-pushing formalism is used to show the step-by-step transformation of reactant(s) into product(s). For a variety of reasons, however, previous research indicates that students tend to struggle with electron-pushing tasks. Among the many sources of difficulty, we previously demonstrated that the specific format in which a task is represented significantly affects student reasoning and accuracy. The relationship between item format and student response is known as representational determinism. The goal of this study is to further explore how representations of electron-pushing tasks might impact student responses to predict-the-product tasks focusing on nucleophilic aliphatic substitution and elimination, which is one of the foundational reaction classes in organic chemistry. Using a combination of multiple-choice and open-ended items administered in Qualtrics, we collected data from 56 students enrolled in Organic Two. In this presentation, we describe the development of the survey items and data analysis procedures. We also present preliminary findings, which suggest that, in the context of predict-the-produce tasks, familiarity heuristics may supersede representational determinism in students' decision-making.

#42 INFLUENCE OF INSERTION LESIONS AND AG MISMATCHES ON DNA BACKBONE DYNAMICS

Theodora Osborne. Chemistry and Biochemistry. Faculty Advisor: Dr. Gary Meints

Mismatches, insertions, and deletions of nucleotides during DNA replication can contribute to many diseases, including cancer and genetic diseases. DNA repair enzymes recognize these changes and can often reverse these modifications before they cause incorrectly coded proteins that harm the cell. It has been suggested that these enzymes rely on the dynamics of the phosphate groups of the backbone around the mutation to correctly recognize and repair the mutations. The purpose of this study is to further investigate the role of backbone phosphate dynamics in recognition and repair of mutations by characterizing the backbone dynamics of an A:G mismatch and T insertion using solution 1H and 31P NMR and comparing the obtained shifts to the unaltered counterparts. It was found that the BI% and BII% varied in the nucleotides closest to the lesion, and the ΔG of the equilibrium between BI and BII conformations varied as well, which indicates that enzymes' use of backbone phosphate conformation to recognize mutations is very likely.

#43 THE PURIFICATION & CHARACTERIZATION OF 15N LABELED TGP-E: THE BEGINNINGS OF STRUCTURAL COMPARISON

Alexandra Smalley, Chemistry and Biochemistry, Faculty Advisor: Dr. Natasha DeVore

This experiment highlights the preparation of Thermal Green Protein Q66E for comparison of its determined crystal structure to Heteronuclear Single Quantum Coherence (HSQC) NMR data using 15N labelling. Preliminary NMR data was collected by Washington University in St. Louis to establish a baseline. Preparation of protein for NMR trials include purification, characterization, and concentration of samples. Low Flow Chromatography and SDS-Page gel were run to purify and confirm purity of TGP-E. The protein is roughly 28 kDa with a possible dimer formation. Absorbance and fluorescence of TGP-E was measured on a UV-vis spectrophotometer and a fluorescence spectrophotometer to establish excitation and emission. The florescence emission was found to be at 508.00 nm and excitation was at 492 nm. Future analysis of structure and NMR data will correlate Hydrogen-Nitrogen bonding to the changes in protein functionality.

#44 DOXORUBICIN PRODRUG ENCAPSULATED ACTIVATABLE MR NANOPROBE FOR THE THERANOSTIC TREATMENT OF CANCER

James Speake. Department of Chemistry. Faculty Advisor: Santimukul Santra*

The secondary phase of cancer treatment generally starts with imaging of the region of interest to track for development and malignant cell growth. One commonly used technology is magnetic relaxation imaging (MR Imaging). Along with imaging, post-primary treatment often involves some form of chemotherapy as the adjuvant therapy. To make this process more efficient, we propose a novel, activatable, theranostic nanoprobe, Gadolinium-DTPA disulfide-bonded doxorubicin (Gd-DTPA-SS-Doxo) encapsulated in iron oxide nanoparticles (IONPs). Gd-DTPA-SS-Doxo has the potential to provide functionality in imaging malignant cancer while also targeting the cells with treatment options. First the Gd-DTPA-SS-Doxo is synthesized, then encapsulated within the poly acrylic acid (PAA) coating of IONPs. This produces the nanoprobe (IO-Gd-DTPA-SS-Doxo) with quenched longitudinal spin lattice (T1) magnetic relaxation. After receptor-mediated endocytosis of the nanoprobe to the cell, the acidic microenvironment of the tumor releases the nanoprobes polymeric coating. Gd-DTPA-SS-Doxo is still quenched until the intracellular glutathione (GSH) tripeptides present in the tumor cell cleave the disulfide linkage. This releases the Gd-DTPA complex and Doxo enabling simultaneous activation and cytotoxic effects, respectively. All in all, the proposed dual mode theranostic activatable system of Gd-DTPA-SS-Doxo allows for synchronous MR imaging of malignant cell growth, along with targeting and treatment for cancer.

#45 REDOX-ACTIVE NANOSTRUCTURES WITH ULTRAHIGH CATALYTIC ACTIVITY FOR COLORIMETRIC APPLICATIONS.

Abby Teitelbaum, Rahab Kanogo, Eniola Arogunyo, Mitchell Kim, Alexis Holyfield, Trishna Timalsena, Fei Wang, Santimukul Santra and Tuhina Banerjee.* Chemistry and Biochemistry. Faculty Advisor: Tuhina Banerjee

For the past few years, conventional peroxidase-mimics of nanoscale materials have found limited applications due to their low catalytic activity. Hence it is desirable to control and tune their physicochemical properties through precise engineering to achieve superior catalytic efficiency. Herein, we demonstrate an efficient strategy for substantially improving the peroxidase-mimetic activity of nanomaterials, particularly those that exhibit mixed-redox states. These redox-active nanostructures consist of cerium oxide core and are decorated with several plasmonic gold nanoparticles within its polyacrylic acid polymer coating (PNC). Synthesized PNC nanostructures exhibited enhanced catalytic activity ($K_{cat} \sim 10^6\ s^{-1}$) which was several folds higher than natural peroxidases. Using *E. coli O157:H7* as a target pathogen, it is demonstrated that when PNC is applied as peroxidase mimic for enzyme-linked immunosorbent assay (ELISA), limits of detection were much lower than the conventional assays employing natural enzymes.

#46 FUNCTIONAL MAGNETO-PLASMONIC NANOSENSOR (MPNS) FOR SENSITIVE DETECTION OF FOODBORNE PATHOGENS

Trishna Timalsena. Department of Chemistry and Biochemistry. Faculty Advisor: Santimukul Santra*

Food contamination poses a major public health threat, with the World Health Organization (WHO) estimating 600 million illnesses and 420,000 deaths globally each year due to contaminated food. Among food-borne pathogens, Escherichia coli O157:H7, a Shiga toxin-producing E. coli (STEC), is especially concerning due to its low infectious dose and frequent involvement in outbreaks. Early detection at low colony-forming units (CFUs) is crucial to prevent transmission. Conventional methods such as qPCR, whole genome sequencing (WGS), and immunoassays offer reliable detection but are often costly and time-consuming. To address these limitations, a multifunctional plasmonic nanosensor (MPnS) was developed by integrating iron oxide nanoparticles (IONPs) and citrate-coated gold nanoparticles (GNPs). This system combines the magnetic properties of IONPs with the colorimetric surface plasmon resonance (SPR) of GNPs for dual-mode detection. Upon binding with E. coli, MPnS undergoes a red-to-purple color change and generates a T2 magnetic relaxation signal, enabling both visual and quantitative analysis. The assay demonstrated high sensitivity, detecting as low as 10 CFUs in both buffer and milk within minutes, with no cross-reactivity. Overall, MPnS provides a rapid, user-friendly, and ultrasensitive platform for detecting E. coli O157:H7, with strong potential for adaptation to other food-borne pathogens.

#47 IMAGE PROCESSING PIPELINE FOR QUANTIFICATION OF TEST LINE INTENSITY IN LATERAL FLOW ASSAY STRIP IMAGES

Keegan Spell, Santimukul Santra, Tuhina Banerjee. Computer Science. Faculty Advisor: Mukulika Ghosh.

Quantification of test line intensity in lateral flow assay (LFA) strips is critical for enhancing the analytical performance and interpretability of wet-test results. This project focuses on developing a learning-based image processing pipeline for the accurate measurement of colorimetric signal intensities in LFA strips captured under variable conditions using smartphone cameras. The proposed method involves region of interest (ROI) extraction using a U-Net model, combined with color space transformation and traditional image processing techniques, followed by intensity profile analysis along the strip axis to quantify the test line intensity relative to the control line intensity. Pre- and post-processing using traditional image processing techniques—such as noise reduction, intensity normalization, and adaptive thresholding—are applied to improve the reliability of the learning-based approach, especially when trained on a limited dataset and used under diverse lighting environments. The learning-based model is used to isolate the region containing the test and control lines in images captured under various background colors and illumination conditions. Experimental results validate our approach for strip images taken under varying lighting conditions and demonstrate an increase in measured intensity corresponding to higher pathogen concentrations in the strips.

#48 A WEB-BASED TOOL FOR ASSESSMENT AND RECOVERY OF CYCLONE DAMAGES IN THE SUNDARBANS

Mohamed Alakwa, D. Berndt, W. Moussa, J. Bowman – Computer Science
Faculty Advisor: Dr. Asif Ishtiaque

This project describes a web-based decision-support tool developed to assess cyclone damage to and estimate vegetation recovery time within the Sundarbans mangrove forest. The system uses NDVI (Normalized Difference Vegetation Index) calculated from Sentinel-2 and Landsat satellite imagery data to account for the vegetation that has been affected by cyclone events. The system allows users to upload recent satellite images, which are compared with historical NDVI data (1990–2020) to identify damage hotspots. It predicts the recovery time at a pixel level, which is based on vegetation recovery patterns. Through an overlay heat map on the combined interface of Google maps users can visualize and analyze the affected areas. We manage satellite image mosaicking and preprocessing on the backend, while enabling front-end interaction through a React-based UI. Geospatial standards and RESTful APIs provide for interoperability and easy access. As a non-technical tool, this can be helpful for local forest managers or government or policy makers, allowing them to use data for more informed restoration activities and to implement more targeted actions. Its design allows for post-cyclone environmental assessment that is more efficient, scalable, and accessible when compared to traditional field-based approaches.

#49 AUTOMATED MACHINE LEARNING FRAMEWORK FOR E. COLI DETECTION FROM IMAGES OF NANOZYME-BASED CATALYTIC SOLUTIONS

Samantha Malca. Computer Science and Biochemistry. Faculty Advisor: Tayo Obafemi-Ajayi
Co-Advisors: Tuhina Banerjee and Santimukul Santra

Foodborne illnesses pose a significant public health challenge, with *Escherichia coli* (E. coli), particularly the shiga toxin-producing strain. To support early detection and intervention, this project introduces a machine learning (ML)-based framework for identifying E. coli concentration levels from images of nanozyme-based catalytic assay solutions. Using a magneto-plasmonic nanosensor (MPnS), the assay generates visible colorimetric changes depending on bacterial concentration. All images were captured using a smartphone camera and processed with OpenCV. The dataset was curated and preprocessed using automated segmentation techniques such as morphology and watershed algorithms to isolate the reaction zones. Blue color intensity was identified as the most reliable feature for determining E. coli concentration, with gold nanoparticles showing peak absorbance at ~10^7 CFU. Pixel-based color metrics were extracted to generate a total of twelve features, which were used to train a lightweight ML classifier capable of predicting concentration levels. Due to a limited number of available images, Synthetic Minority Over-sampling Technique (SMOTE) was applied to augment the dataset and improve model performance. The final objective is to integrate this model into a mobile application, enabling real-time, low-cost detection of E. coli contamination from assay solution images for rapid field diagnostics and food safety monitoring.

#50 ARCHITECTURAL REDUNDANCIES IN THE DOZERFORMER ATTENTION MODEL ON TIME-SERIES PREDICTIONS.

Christopher Housholder, Zelun He, and Vivian Ning. Computer Science. Faculty Advisor: Yifan Zhang

We study the structure of the Dozerformer attention model in the context of continuous time series prediction, with the goal of identifying architectural redundancies. In particular, we evaluate whether either the encoder or decoder module can be removed without significantly impacting performance. To this end, we conduct a set of ablation experiments in which each component is independently removed and the resulting model is trained and evaluated across a range of continuous time series tasks. Our results show that the encoder plays a critical role in learning and maintaining temporal structure, with its removal leading to sharp declines in predictive accuracy. In contrast, removing the decoder results in little to no performance loss in most cases, suggesting that it may be partially redundant in this setting. These findings highlight the asymmetry of importance between encoder and decoder in time series applications and suggest that attention-based models for continuous signals can be simplified without compromising effectiveness. This contributes to ongoing efforts to streamline transformer architectures and improve efficiency in real-world temporal modeling tasks.

#51 SHATRANZ: THE REAL-TIME TRANSLATION APPLICATION

Christopher Housholder, Summer White, Seojin Park, Samantha Malca, and Zelun He. Computer Science. Faculty Advisor: Adnan Maruf

We present ShaTranz, a real-time translation application designed for seamless, cross-language communication. The mobile front-end is built in Kotlin, offering an intuitive and responsive user interface, while the backend is developed in Python to handle processing, routing, and service integration. ShaTranz leverages Google's suite of APIs to manage voice input, language detection, translation, and audio/text output, ensuring high accuracy and minimal latency across supported languages. Designed with usability and speed in mind, the app enables live conversations by translating speech or text inputs into the target language in real time. The architecture emphasizes modularity and scalability, allowing easy adaptation to future API enhancements or integration with additional features such as conversation logging or offline support. By combining robust cloud services with efficient local execution, ShaTranz provides a practical and accessible solution for real-time multilingual interaction.

#52 SILICON SIGNALS (SiGNAL): A MODULAR SYNTHESIZER FOR INTUITIVE SOUND DESIGN

Preston Carroll, Nathan Swan, Ben Alexander. Electrical and Computer Engineering. Faculty Advisor: Dr. Rohit Dua

Modular synthesizers are typically perceived as an intimidating instrument for any musician due to their complex and open-ended nature. SiGNAL aims to close this gap by offering a set of modules that offer simplicity and sonic possibility. Focusing on core components - oscillators, filters, modulators, and effects - engineered to generate high-fidelity analog sounds ranging from traditional to experimental. A key component is the added oscilloscope module, which provides real-time waveform visualization to help users intuitively grasp each module's function. By combining the warmth and character of analog sound with user-friendly design, SiGNAL presents an affordable modular synthesizer solution for musicians looking to extend their creative possibilities without confronting the typical barriers to entry in modular synthesis.

#53 DiSeCT (DISCRETE SEMICONDUCTOR CURVE TRACER)

Benjamin Cuebas and Justin Fausto. Faculty Advisor: Dr. Rohit Dua

The DiSeCT (Discrete Semiconductor Curve Tracer) is a standalone benchtop device that will quickly and automatically generate the I-V curve/s for a select group of semiconductor components: Rectifier Diodes, Zener Diodes, NPN BJTs, PNP BJTs, N-channel MOSFETs, and P-channel MOSFETs. The device consists of custom-designed precision electronics that utilize I2C, a serial communication protocol, to iteratively apply user-defined biasing conditions to the component and measure all data needed to plot the I-V curve/s. The DiSeCT displays the I-V curve/s on a touch screen, with a built-in GUI for device interaction, allowing the user to analyze results immediately after testing. The user can also export the data points of the curve to a file that can be analyzed more extensively by data-analysis software like Microsoft Excel or MATLAB, resulting in both convenience and flexibility.

#54 INTERACTIVE MAGLEV TRAIN MODEL

Brenyn Freeman, Brady Pry, Vadim Grishchuk. Electrical Engineering, Faculty Advisor: Dr. Tayo Obafemi-Ajayi

This project presents a tabletop demonstration of a magnetically levitating (MagLev) train system designed as an educational tool for applications of electromagnetic principles. The system uses N52 neodymium magnets for levitation and electromagnetic coils for propulsion. The coils are pulsed by a microcontroller through a cascode gate driver that switches a 30 V supply. A magnet mounted in the train is detected by Hall sensors placed after each set of coils, which send a signal to the microcontroller to trigger the next pulse. The pulse pushes the train along the track, with strength adjusted by PWM (pulse-width modulation), controlled via a potentiometer on the human-machine interface. This interface also displays real-time feedback on power consumption and velocity, adjustable from 1.5 to 3.5 ft/s. A repurposed ATX power supply provides 5 V and 12 V power for the Hall sensor circuits and the microcontroller, while a boost converter steps the 12 V up to 30 V for the coils. Through direct engagement and visualization, the project encourages student interest in advanced engineering topics and practical applications of electromagnetism.

#55 A LAB-SCALE TEST STAND FOR EVALUATING THERMAL ENERGY STORAGE USING DIFFERENT MODES OF HEAT TRANSFER

John Reeves, Stone Simpson, Ahmad Wijahat. Cooperative Engineering. Co-Authors: Dr. Daniel Moreno, Faculty Advisor: Daniel Moreno

This project explores liquid water's ability to store thermal energy, a potentially cost-effective method to store energy from renewable sources like solar radiation. A lab-scale test stand was used to test how well the temperature and volume of water are retained based on heating mode, insulation, and steady-state temperature. Preliminary testing involved heating a 500 mL beaker of water to steady-state temperatures of 40-55 °C using conduction (hot plate), convection (immersion heaters), and radiation (heat lamp). These tests suggest that the heating method has an impact on the volume of water lost due to evaporation. Convection caused a loss of 2%, while conduction resulted in a 10% loss, and radiation led to a 5% loss. The results for the heat lamp,are of particular interest due to its similarity to solar radiation. Further testing aims to explore

insulation effectiveness, target temperature, and pumping heated water into a storage beaker. A model was developed to predict water temperature based on initial conditions and pump rate and is currently being refined to better reflect experimental data. In addition to research goals, the setup also serves as an educational tool for demonstrating heat transfer concepts.

#56 THE GAUNTLET — CREATING A RESPONSIVE PROSTHETIC HAND THROUGH ADVANCED CONTROL SYSTEMS

Maya VanCardo, Charlie Bednar, Anneli DeRousse, Adin Sommerer. Electrical and Computer Engineering. Faculty Advisor: Dr. Tayo Obafemi-Ajayi.

The demand for prosthetic devices that offer both functionality and ease of use has been steadily increasing as traditional prosthetic hands are often limited in their movement and responsiveness, which impacts the user's ability to perform a wide range of everyday tasks. This project presents The Gauntlet, a cost-efficient, 3D-printed prosthetic hand developed to replicate basic hand functions through predictive motion control and tactile feedback. It combines sensor integration with advanced control algorithms to achieve responsive, adaptive hand motions and grasps of varied objects. Using three HerkuleX Smart Servo motors and an Arduino microcontroller, the system executes user-initiated gestures such as grasping, pointing, and a thumbs-up. Pressure-sensitive resistors installed in the fingers provide real-time feedback to regulate motor movement and prevent excessive force. A custom-designed PCB was implemented to streamline sensor and input connections while minimizing internal wiring. The results of the functional tests on reaction time, range of motion, and adaptive grip strength demonstrate successful grasping of objects of varying shapes and weights and consistent motor response. By integrating feedback control theory, affordability, and modular design, The Gauntlet demonstrates a practical step toward improving accessibility and usability in upper-limb prosthetic technology.

#57 NETWORKED SENSOR PLATFORM FOR LOCAL ATMOSPHERIC AND SEA HARZARDS

Adam Iturria, Steven Kang, Victor Azoji. Electrical and Computer Engineering. Faculty Advisor: Rohit Dua.

This project is a compact, low-cost marine weather monitoring system that tracks wind speed and direction, atmospheric and water temperature, atmospheric pressure, UV levels, relative motion, velocity and GPS data. A Raspberry Pi Zero 2 W collects and processes sensor inputs, transmitting data via NMEA 2000, Bluetooth, and LoRa WAN. The system is housed in an IP67-rated (dustproof and waterproof) enclosure and features an uninterruptable power supply for power backup. Compared to commercial options, it is smaller, more affordable, and includes storm alerts. Calibration routines and real-world testing confirmed sensor accuracy and 5 km LoRa range.

#58 ALTERNATING CURRENT BIKE POWER GENERATION SYSTEM

Noah Lamb, Donovan Drake, Jake Thompson. Electrical Engineering. Faculty Advisor: Rohit Dua

SpinSync is an interactive educational system designed to demonstrate the generation of alternating current (AC) power using a bike-powered direct current (DC) generator. The system integrates several key subcomponents, including a bicycle, DC generator, pulse-width modulation (PWM) controller, gate driver circuit, rectifier, step-up transformer, filter circuit, and an AC load bank. By converting mechanical energy into electrical energy and then inverting it to a 120V, 60Hz AC sine wave, SpinSync offers users a hands-on experience that illustrates each stage of the power conversion process. The project aims to simplify complex power generation concepts through real-world applications, enabling participants to power various light loads while deepening their understanding of power generation systems.

#59 CONVERGENCE OF CLASSICAL AND NONLOCAL CURVATURE.

Christopher Housholder. Mathematics. Faculty Advisor: Animesh Biswas

We study the recently introduced notion of nonlocal mean curvature, defined via an integral operator involving a convolution kernel. Specifically, we consider curvature of a set $\Omega \subset \mathbb{R}^2$ defined by an integrable, radially symmetric, nonnegative, and nonincreasing kernel J, and examine the behavior of the resulting nonlocal curvature functional. Building on previous work, we extend the definition to higher dimensions and investigate its convergence properties in the classical limit. Our main result shows that for sets with C^2-boundary, nonlocal mean curvature converges to the classical mean curvature as the support of the kernel shrinks to zero. This confirms that integrable kernels can faithfully recover local geometric information and provides a concrete bridge between nonlocal and classical curvature models.

#60 VC-DIMENSIONS OF SUBSETS OF THE HAMMING GRAPH.

Christopher Housholder and Layna Mangiapanello. Mathematics. Faculty Advisor: Steven Senger

Subsets of the Hamming graph H(2,q) were studied with respect to their VC-dimension under the neighborhood model, where each set consists of the neighbors of a vertex. Building on work from PSTT, we examined configurations in H(2,q) for q >= 3 and determined exact thresholds for when a subset attains VC-dimension at least 2 or 3. We provide simplified proofs of known results and introduce new constructions that demonstrate the sharpness of these bounds. In particular, we show that the minimal subset size required to guarantee VC-dimension 2 depends on the parity of q, and that VC-dimension 3 occurs precisely when the subset size exceeds 3q. These results fully characterize VC-dimension behavior in ambient dimension 2 and identify structural conditions that govern shattering. The Hamming graph's resistance to standard pseudorandom techniques is discussed, with our approach instead relying on elementary combinatorial and geometric arguments. Since VC-dimension plays a central role in learning theory, particularly in bounding model complexity and generalization, our results have implications for machine learning tasks involving discrete, categorical, or graph-structured input.

#61 CLIMATE IMPLICATIONS FOR HABITATBLE ZONE PLANETS IN SYSTEMS CONTAINING A NEARBY JUPITER

Armitha Dutta. Physics, Astronomy and Material Science. Faculty Advisor: Sarah J. Morrison

The orbital configuration and dynamical stability of planetary systems are governed by gravitational interactions, orbital configurations, and the presence of massive planetary bodies. By conducting dynamical simulations of planet formation in the vicinity of a Jupiter-mass planet at 3 AU, the resulting planetary system architectures and the potential for long-term dynamical stability and habitability within the habitable zone (HZ) of a G-type star were assessed. A series of N-body simulations, utilizing the Mercury Hybrid Integrator, were performed to quantify the influence of the giant planet on the mass, eccentricity, and orbital location of inner planets, considering both a gas-rich residual disk phase and a subsequent gas-depleted phase. Results indicate that, despite the presence of an exterior Jupiter analog, a significant fraction of inner planets maintain dynamically stable orbits over the simulated timescales, with 50% of surviving planets classified as super-Earths. These findings suggest that the presence of an outer gas giant does not invariably lead to the ejection or destabilization of inner planetary systems. To further examine habitability, climate modeling of selected surviving planets will be conducted, investigating factors that may limit or enhance habitable conditions within these dynamically sculpted systems.

#62 ORBITAL PERTURBATIONS AND CLIMATIC IMPACT TO HABITABLE ZONE PLANETS FROM MASSIVE PLANETS AT THE SNOWLINE AROUND M STARS AND G STARS

Bishwash Devkota. Physics, Astronomy and Material Science. Faculty Advisor: Sarah J. Morrison

Massive planets forming near the water ice snowline can significantly influence the orbits of Earthmass planets in the habitable zone (HZ). This study uses N-body simulations to examine orbital perturbations in planetary systems around G-type and M-type stars. Configurations include a Jupiter-mass planet at the snowline of a G star and a Neptune-mass planet at the snowline of an M dwarf, with Earth-mass planets positioned at various locations within the HZ. The analysis focuses on variations in semi-major axis, eccentricity, and the timescales of these changes. Results show that perturbations are stronger around M stars due to the snowline's proximity to the HZ, leading to higher eccentricities and more significant shifts in orbital distance. These changes directly affect the time-averaged stellar flux received, introducing potential climatic instability. To evaluate the impact on long-term habitability, a comprehensive habitability map is being developed that integrates orbital stability, stellar flux variation, and climate thresholds.

#63 SEARCHING FOR CORE-COLLAPSE SUPERNOVAE USING MACHINE LEARNING ALGORITHMS

Simarpreet K. Girn, Bishwash Devkota, Marco Cavaglia. Physics, Astronomy and Material Science. Faculty Advisor: Ridwan Sakidja.

This project explores new ways to help scientists detect signals from exploding stars, known as core-collapse supernovae, using machine learning. These signals, captured through gravitational-wave detectors, can be challenging to identify because they often look similar to background noise. A previous study addressed this problem using a method called genetic programming to classify events based on features extracted from gravitational wave data. In this project, that approach is replaced by the Quantum Kernel Support Vector Machine (QSVM). This approach uses a quantum circuit to transform the data before it is analyzed by a traditional machine learning model. The QSVM results are compared to genetic programming to see how well this new approach performs in detecting real signals.

#64 THE MYSTERIOUS FATE OF EXOMOONS AROUND WARM-JUPITERS

Simarpreet K. Girn. Physics, Astronomy and Material Science. Faculty Advisor: Sarah J. Morrison

In recent years, the study of exoplanet systems has revealed a diverse range of planetary configurations, each aiding the understanding of planetary formation and evolution processes. Among these systems, warm Jupiters stand out as objects of interest, characterized by their proximity to their host stars and the potential complexities of their formation histories. Understanding the dynamics of exomoons forming around warm Jupiters may provide valuable clues about the stability of exomoons around these objects. For this project, dynamical simulations will be conducted using the N-body code REBOUND to understand exomoon formation and stability for these high-mass objects over long timescales. These studies will produce the stability maps of possible stable orbit configurations of exomoons around observed warm Jupiters. Factors such as orbital resonances, tidal forces, and other body perturbations would be included. This project aids in interpreting multi-exoplanet systems discovered and characterized during the Kepler mission and the ongoing mission of NASA's Transiting Exoplanet Survey Satellite (TESS).

#65 CHITOSAN NANOPARTICLES INCORPORATED WITH VARIOUS SURFACTANTS FOR OPTIMAL CANCER DRUG DELIVERY

Lana Janson, Wade Van Riessen, Markos A. Georgy. Physics, Astronomy and Material Sciences. Faculty Advisor: Robert A. Mayanovic

Chitosan nanoparticles have shown considerable promise for cancer drug delivery. As such, chitosan nanoparticles must possess responsivity to varying pH levels in route from normal tissue to the cancer site, while having the capacity to easily discharge the loaded drug in the cancerous tissue. The chitosan nanoparticles (CSNPs) were prepared using dilute gelation by drop-wise addition of tripolyphosphate (TPP). Each set of CSNPs were incorporated with a 77KS surfactant, which is as a pH-sensitive adjuvant for drug delivery, whereas some were incorporated with polyvinyl alcohol (PVA). In addition, a separate batch of the CSNP-77KS with or without PVA samples were loaded with doxorubicin (DOX). The nanoparticles have been characterized using x-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR). The XRD results indicate that all CSNPs incorporated with 77KS attain a substantial increase in the degree of crystallinity in relation to ones without the 77KS surfactant. Additional results from this study will be reported.

#66 INVERSE DESIGN WITH PHYSICS-INFORMED NEURAL NETWORKS FOR ELECTROMAGNETISM (E&M)

Theo Luan. Physics, Astronomy and Materials Science. Faculty Advisor: Ridwan Sakidja

As part of our PHY353 Electromagnetism course project, we applied Physics-Informed Neural Networks (PINNs) to solve inverse problems by combining machine learning with physics laws. We focused on two key Maxwell equations: Poisson's equation, used to extract charge density from electrostatic potential, and Ampère's law, applied to recover magnetic fields and estimate current density from measured data. PINNs are trained not only to match data, but also to obey physics laws by including them directly in the loss function. This allows the model to make accurate predictions, even with limited or noisy input. Our results show that PINNs offer a powerful and flexible approach to solving E&M problems, with practical applications in sensor analysis and electromagnetic system design.

#67 REPLICATING THE USDA/PRISM METHOD OF MAPPING PLANT HARDINESS ZONES IN ALASKA

Grace Chalfant. Geology. Faculty Advisor: Toby Dogwiler

Beginning in the 1990s, the US Department of Agriculture has periodically published Plant Hardiness Zone (PHZ) maps to guide the public on the suitability of different plants across various regions of the country. PHZ maps visualize patterns of annual extreme low-temperature severity, which is the primary determinant of perennial plant survival. Our study aims to replicate and validate the methods utilized by the USDA and the PRISM Climate Group at Oregon State University – methods that are considered proprietary –to apply these methodologies to other countries in future studies. Using ArcGIS Pro, maps were generated based on 30-year averaged data of the lowest annual extreme minimum temperatures from 1975 to 2000. A comparison of our map with the 2012 PHZ map illustrates the degree to which our methods replicate the USDA/PRISM methods. Our map differs by approximately two and a half zones warmer on average. We believe this discrepancy is partly due to interpolation methods used by PRISM to estimate missing weather station data. These findings will hopefully contribute to the development of PHZ maps in other regions of the world to better assess how climate impacts plants.

#68 A CONTINUED RESEARCH ON EXAMINING PUMICES AND LAVA FLOWS FROM SOCOMPA VOLCANO

Noah Short. Geology. Faculty Advisor: Toby Dogwiler

The aim of the former study was to determine whether the Holocene post-collapse deposits (pyroclastic fall and flows) of Socompa Volcano were sourced from the same magma plumbing system: particularly, whether the plagioclase content and chemistry within the pumices correlate with the same plumbing system as the lava flows.

Analysis was conducted to determine Fe (ppm) and Mg (ppm) content of the plagioclase. The maximum and minimum percentage of Anorthite found within the plagioclase was found to be 51% and 26%, respectively. The maximum and minimum Fe (ppm) was found to be 7144 ppm and 773 ppm, respectively, and Mg (ppm) was 2274 ppm and 0 ppm, respectively.

The data from EPMA showed an anomaly with plagioclase in one of the two pumice samples analyzed, SOC23-05B: specifically, pumice sample SOC23-05B deviated from its main, linear course, and split, becoming a new set of data with a linear trend. In addition, laser ablation was used, along with the trace element composition, which suggested there were several populations of plagioclase within the pumice sample. This research will focus on this deviation by using laser ablation, and trace element composition.

#69 LOCATING WATER MONITORING SITES AT A LANDFILL AT A SPRINGFIELD CITY UTILITIES LANDFILL USING ELECTRICAL RESISTIVITY AND VERY LOW FREQUENCY ELECTROMAGNETIC SURVEYS

Harry Whitehead. Geology. Faculty Advisor: Kevin Mickus

The Twitty Energy Center uses coal to generate electricity and the waste from the coal (coal ash) is stored in landfills. To monitor the groundwater surrounding the landfill for potential contamination, the Energy Center was mandated to drill monitoring wells into the Springfield Aquifer. To determine the best location for these wells, a geophysical survey was conducted on all sides of the rectangular landfill. The geophysical survey consisted of twenty-seven electrical resistivity profiles and a very low frequency electromagnetic (VLF-EM) survey. These surveys were oriented N-S,and E-W, surrounding the ash pile, along with one diagonal profile on each corner of the pile. The electrical resistivity profiles were 275 meters long with electrodes spaced at 5-meter intervals. The VLF-EM survey consisted of taking readings every 2-5 meters along several profiles. The electrical resistivity models indicate that the aquifer was between 15-20 meters below the surface in all directions from the landfill with regions on the northeast, northwest and southeast portions best for locating the monitoring wells. Other regions showed several karst features (sinkholes) where monitoring wells should not be located. The VLF-EM results including maps and two-dimensional models agree with these results.

#70 IN-CHANNEL SEDIMENT DEPOSITION PATTERNS ALONG 424 KM OF THE GASCONADE RIVER IN MISSOURI

Kayla May, Dr. Bob Pavlowsky, Marc Owen, Josh Hess, Brianne Edwards. Geomorphology. Faculty Advisor: Marc Owen.

The spatial distribution of entrained sediment deposited on channel bars is highly influential on in-channel, aquatic habitat suitability. The purpose of this study was to analyze sediment size class (SSC) trends along the full length (424 kilometers) of the Gasconade River. A gravelometer was used to perform 'pebble-counts', measuring the B-axis diameter of 95 sediment samples from each bar: 30 each from the bar head, mid, and tail, as well as 5 of the largest clasts at the bar head. A total of 14 sites, with a variety of stable and disturbed reaches, were sampled, for a total of 4,685 SSC measurements from 49 different bars. Sediment size generally decreased downstream with slope. Percent fines on bar surfaces increased in the lower valley, and larger size clasts were found at bar heads. Significant variability in SSC between sites was attributed to proximity to and confinement from rock bluffs, upstream tributary inputs, and availability of course sediment material from local geological and bank erosion.

THE JUDGES

updated 4/22/2025

Biology

Ecology/Wildlife/Conservation

Lloyd Morrison, Ecologist, National Park Service
Hae Kim, Biology Visiting Instructor, MSU
Brianne Edwards, Research Scientist, OEWRI

Cell Biology/Microbiology/Genetics

Rhy Norton, Lab Manager, Dynamic DNA Labs
Dr. Ram Nayar, Microbiology Emeritus Professor

Chemistry

Geoffrey Manani, V.P. of Operations, ChemBle Solutions
Melinda Sutton, R&D Chemist, Gem Gravure

Computer Science

Aubrey Hormel, Senior Data Scientist, Husch-Blackwell
William Padfield, Senior Data Scientist, Husch-Blackwell

Cooperative Engineering

Sam Whittington, Planning Engineer, Toth and Associates
Justin Sherman, Transmission Engineer, Toth and Associates
Isaac Hargrave, Associate Planning Engineer, Associated Electric Cooperative Inc

Geography, Geology & Planning

Geology

Bobbilynne Koepke, Remediation Operations Manager, Environmental Works, Inc.
Drew Laviada-Garmon, Geophysicist, Terracon

Geography/Geospatial/Planning

Travis Carr, GIS Technician, City of Nixa
Scott Godbey, Director of Planning and Development, City of Nixa

Mathematics

Don Tosh, Professor, Department of Natural and Applied Sciences, Evangel University
Al Dixon, Professor, Department of Math-Physics, College of the Ozarks

Physics, Astronomy & Materials Science

Stephanie A Blake, BioClinical Faculty, Ozarks Technical College
Bishwajite Karmakar, Brewer Science Inc, JVIC

BIOLOGY

Study in biology opens the doors to a variety of rewarding careers. Career areas for biology majors include the health-care field; industry research, development, and testing (including biomedical and biotechnology fields); conservation, ecology, and wildlife biology; and science education. A degree in biology is excellent preparation for entry into the health professions because the study of biology gives clear insights into the nature of health and disease. Training provided in our bachelor's degree programs can lead to entrance to professional schools in medicine, optometry, dentistry, veterinary medicine, pharmacy, and many other health-related professions. Biology graduates also find a wealth of opportunities in rapidly growing biotechnology, food technology and pharmaceutical industries. Our program emphasizes laboratory experiences, and many positions in these industries place a premium on laboratory skills that can be gained through undergraduate coursework. Another important field for our majors is environmental biology, including conservation, wildlife and resource management, aquatic biology and environmental assessment. Employers in these fields include many federal, state and local government agencies, as well as environmental consulting firms, toxicology laboratories, research-oriented museums, zoological parks and aquariums and public-service environmental organizations.

CURRENT RESEARCH

- **Michelle Bowe** – Phylogenetics, Plant Taxonomy, Evolution, Herbarium
- **Paul Durham** – Migraine, TMD, Nutraceuticals, Inflammation
- **Debra Finn** – Stream Ecology, Connectivity, Aquatic Insects, Communities, Populations
- **Brian Greene** – Herpetology, Snake Ecology, Conservation
- **Takehiro Kado** – Mycobacteria, Immunity, Membrane Dynamics
- **Kyoungtae Kim** – Nanotoxicology, Cell Traffic, Cancer Nanodrug Carrier
- **La Toya Kissoon-Charles** – Pollutants, Aquatic Plants, Biology Education
- **Day Ligon** – Conservation, Herpetology, Physiological Ecology, Aquatic Ecology
- **Sean Maher** – Mammals, Biogeography, Quantitative Biology
- **Alicia Mathis** – Behavioral Ecology, Predation, Territoriality, Chemical Communication
- **Babur Mirza** - Environmental Metagenomics, Microbial Ecology,
- **Avery Russell** – Behavioral, Evolutionary, Microbial Ecology
- **Alexander Wait** – Plant Ecology, Restoration, Conservation

CHEMISTRY & BIOCHEMISTRY

The Department of Chemistry & Biochemistry at Missouri State University has 16 tenured/tenure-track faculty, 2 instructors, 3 staff members, 22 graduate students, and 140 majors. The Department has maintained programs approved by the American Chemical Society Committee on Professional Training since 1974 and offers tracks designed to help students achieve successes in a variety of career directions, including graduate school, industrial applications, medical school, biotechnology, materials development, and environmental engineering. The primary goal of the department is to produce graduates with a sound background in the fundamental areas of chemistry and a working knowledge of modern instrumentation. Toward this end, all chemistry majors have the opportunity to experience hands-on training with a broad range of instruments in their course work, and all majors participate in undergraduate research, which offers opportunity for real-world application of coursework knowledge and helps to develop critical thinking skills.

CURRENT RESEARCH

- **Tuhina Banerjee** – Biochemical, Biophysical and Nanotechnology
- **Gautam Bhattacharyya** – Organic Chemistry, Chemistry Education Research Qualitative Research Methods, Representational Competence
- **Bryan E. Breyfogle** – Electrochemistry of Materials, Chemical Education
- **Natasha DeVore** – Biochemistry and Structural Biology
- **Nikolay Gerasimchuk** – Inorganic/Bioinorganic Chemistry - Oxime-Bearing Ligands and Their Metal Complexes as Biologically Active Compounds
- **Gary A. J. Meints** – Physical/Biophysical Chemistry, NMR Spectroscopy of Damaged DNA
- **Mark M. Richter** – Analytical - Photoluminescence and Electrogenerated Chemiluminescence (ECL)
- **Cyren Rico** – Analytical, Environmental, Ecological Effects of Nanomaterials and Fluorinated Compounds
- **Santimukul Santra** – Targeted Drug delivery, Nanomedicine, Detecting Pathogens using Nanosensors, Recyclable catalysts, Organic Chemistry, Dendritic polymer synthesis
- **Alan Schick** – Physical/Materials Chemistry - Colloid and Surface Chemistry, Organic thin films, Physical Properties of Polymers
- **Reza Sedaghat-Herati** - Organic and Polymer Chemistry
- **Matthew Siebert** – Theoretical organic and organometallic chemistry
- **Erich D. Steinle** – Analytical, Developing Sensors Based on Nanotechnology and Electrochemistry
- **Adam K. Wanekaya** – Fabrication, modification, characterization and application of nanoscale materials
- **Fei Wang** – Inorganic/Physical Chemistry; high-temperature solid state syntheses, X-ray crystallography, intermetallic compounds, thermoelectric materials, first-principle band structure computation
- **Keiichi Yoshimatsu** - Biosensing, Fluorescent Sensing, Protein and Peptide Science, Polymer Chemistry

COMPUTER SCIENCE

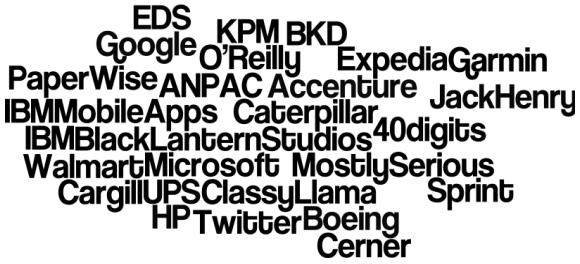
Computer science is a technology-oriented discipline whose fundamental principles combine theory, abstraction, and design. A solid foundation in the fundamental principles is critical to continued learning and adaptation to the technological changes which occur so rapidly in this discipline. The department prepares its graduates for professional employment and graduate education by emphasizing these principles and their application to solution of specific problems, while also addressing the ethical and social issues associated with computing.

All tenure-track faculty members have Ph.D.'s in the field of computer science, which leads to opportunities for Bachelor's degree students to participate in research projects. Faculty lead a variety of research agendas (see below), including neural networks, algorithm design for DNA sequencing, high-level language design, and computer architecture projects on FPGA circuit boards.

MSU's Computer Science program has for many years been accredited by the Computing Accreditation Commission of ABET, www.abet.org. ABET accreditation demonstrates a program's commitment to continuous improvement and to providing its students with a quality education.

ABET Computing Accreditation Commission

As examples of continuous changes in the curriculum and the field of CS, our department has recently added a second option, "Software Development," to the CS degree. In that degree option, students will choose a minor to complement the CS coursework. Our Advisory Board, made up of MSU CSC grads in industry leadership, have told us that a Software Development option will be attractive to their companies.



The salary expectations for computer science majors are nearly the highest of any field. Initial salary offers to MSU CS graduates are outstanding (see Annual Report, ***careercenter.missouristate.edu***), and average starting salaries for 2016 CS grads are projected at $61,321. (See ***www.naceweb.org***). As examples, graduates of the past five years or so work at these recognizable companies, and many have started their own software businesses.

CURRENT RESEARCH

- **Yassine Belkhouche** – Deep learning and Its Application, Machine Learning and Pattern Recognition, Secure Machine Learning, Information Fusion, Computer Vision, Software Engineering, Software Quality Assurance
- **Rahul Dubey** – Machine Learning, Evolutionary Algorithms, Explainable AI, Deep Surrogate Models and Applications in Complex Real-World Problems
- **Mukulika Ghosh** – Robotics, Computation Geometry, Solid and Physics based Modeling, Algorithms, Theory of Computation, Deep Learning
- **Razib Iqbal** – Multimedia Systems and Communications, Digital Content Adaptation, Software Engineering, Software Quality Assurance, Automated Software Verification and Validation, Internet of Things, Computer Security
- **Ajay Katangur** - Cyber Security, Information Assurance, Cloud Computing, Wireless Networks, Computer Networks, Optical Networks, Mobile Computing
- **Anita Liu** – Wireless Ad-hoc, Sensor Networks, Mobile Computing, Parallel and Distributed Computing, and Bioinformatics
- **Siming Liu** - Search, Optimization, Machine Learning, Evolutionary Computation, Artificial Intelligence, Parallel and Distributed Computing, Games and Simulations
- **Adnan Maruf** - Hybrid Memory Systems, Storage Systems, High Performance Computing, System Reliability, System Performance, and Operating Systems
- **Hazhar Rahmani** – Algorithmic Robotics, Artificial Intelligence, Forma Methods in Robotics, Computational Geometry, Data Analytics, Algorithms
- **Jamil Saquer** – Data Mining, Formal Concept Analysis, Machine Learning, Computer Science Education, Graph Theory and Graph Algorithms
- **Lloyd Smith** – Multimedia Digital Libraries, Speech-driven and Multimodal User Interfaces, Music Information Retrieval, Computer-aided Music Education, Pattern Recognition
- **Yifan Zhang –** Deep Learning, Supervised learning, Unsupervised learning, Data Analytics Image Restoration, Algorithms, Computer Vision, Bioinformatics

COOPERATIVE ENGINEERING PROGRAM

Missouri State University and the Missouri University of Science & Technology are proud to offer degrees in Civil Engineering, Electrical Engineering and Mechanical Engineering on the Missouri State University campus. The three engineering degrees are granted by the Missouri University of Science and Technology, in cooperation with Missouri State University. Students are able to complete all four years of the degrees on the Missouri State University campus. The curriculum for the degrees is the same as the curriculum at the Missouri University of Science and Technology. The engineering degrees are accredited by ABET. Missouri State University also has a strong pre-engineering program for students who wish major in other fields of engineering.

Engineers assist in the design and development of all sorts of products. The role of the engineer is to ensure that products are safe, durable, reliable, and cost effective. Engineers develop and follow the codes and standards that are put in place to protect the public safety. Engineering is an honorable profession. Civil Engineers assist in the design of buildings, bridges, dams, levees, water treatment facilities, drinking water facilities, transportation systems, and many other projects. Electrical Engineers assist in the development of power plants, robots, computer systems, electronic control systems, telecommunication systems, and many other projects. Mechanical Engineers assist in the development of internal combustion engines, steam turbines, gas turbines, refrigeration and air conditioning, robots, machine tools, production facilities and many other products. Engineers assist with the design and/or manufacturing of almost every product that we use.

CURRENT FACULTY

- **Dr. Theresa Odun-Ayo** – PhD, Missouri University of Science and Technology
- **Dr. Douglas Carroll** – PhD, Missouri University of Science and Technology
- **Dr. Rohit Dua** – PhD, Missouri University of Science and Technology
- **Dr. Ryan Hutcheson** – PhD, Texas A&M University
- **Dr. Daniel Moreno-German** – PhD, Georgia Institute of Technology
- **Dr. Tayo Obafemi-Ajayi** – PhD, Illinois Institute of Technology
- **Dr. Matthew Pierson** – PhD, University of Kansas
- **Dane Seiler** – BS, Missouri University of Science and Technology
- **Dr. Sanjay Tewari** – PhD, Texas A&M University
- **Dr. Jeffrey Thomas** – PhD, Missouri University of Science and Technology
- **Todd Wagner –** MS, Missouri University of Science and Technology

MATHEMATICS

Mathematics has been called the Queen of the Sciences and also, the Science of Patterns. The essence of mathematics is about discovering and observing patterns, exploring possibilities and consequences, developing quantitative and qualitative sense, and, analyzing and construction solutions to problems, both real world and abstract. The Department of Mathematics offers degree programs which lead to a multitude of career possibilities including teaching, industrial work, government service, and graduate school. Our mathematics education program is the largest in Missouri. Many graduates have pursued graduate studies leading to advanced degrees (we have a Master's program), and professional careers such as college teaching. We also have an excellent pre-engineering program.

CURRENT RESEARCH

- **William O. Bray** - Harmonic Analysis
- **Shahab Abbaspour** – Mathematical Proof in Mathematics Education, Leveraging Technology in Mathematics Education, Statistical and Machine Learning Application in Mathematics Education
- **Animesh Biswas –** partial differential equations, particular nonlocal analysis, application of nonlocal analysis, application of nonlocal analysis in roadway transportation networks, neural network
- **Yue Cui –** Statistics, Nonparametric models
- **Ngoc Do** – Inverse problems, Spectral theory
- **Adam Harbaugh** - Mathematics Education
- **Shelby Kilmer** – Topology, Abstract Harmonic Analysis, Approximation Theory
- **Gay Ragan** – Mathematics Education
- **Jorge Rebaza-Vasquez** – Applied Mathematics, Dynamical Systems, Numerical Analysis
- **Les Reid** - Commutative Algebra, Algebraic Geometry, Combinatorics, and Algebraic K-theory
- **Mark Rogers** – Commutative Ring Theory
- **Steven Senger** - Geometric Combinatorics
- **Kishor Shah** – Commutative Algebra
- **Yingcai Su** – Microarray Data Analysis; Regression with Correlated Errors; Spatial Statistics; Statistical Inference for Stochastic Processes and Random Fields; Monte Carlo and Quasi-Monte Carlo Method
- **Patrick Sullivan** - Mathematics Education
- **Xingping Sun** – Applied Mathematics, Approximation Theory, Computational Analysis, Numerical Analysis
- **Cameron Wickham** - Commutative Algebra, Finite Rings, Homological Algebra.
- **Matthew Wright** – Harmonic Analysis and Partial Differential Equations
- **Songfeng Zheng** – Pattern Recognition and Machine Learning, Statistics Applications, Image Analysis and Statistical Learning Theory

In addition to our professors, the department also has the following dedicated Instructors providing instruction to general education mathematics courses:

Joann Barnett
Patti Blanton
Roger Bunn
Jacob Miles
Shellie Myers
Oana Nelson
Gary Stafford
Kimberly Van Ornum
Fan Zhou

School of Earth, Environment and Sustainability

The School of Earth, Environment and Sustainability is staffed by 20 full-time faculty members. All majors and minors are focused on student involvement in intellectual studies and practical hands-on work in the field and the laboratory. The Center for Resource Planning and Management (CRPM) is an applied research and academic support unit of the Department. Another center within the Department is The Ozarks Environmental and Water Resources Institute (OEWRI). This institute supports efforts to protect and restore water quality and supply in the Ozarks Region. OEWRI initiates and supports research programs aimed at solving environmental problems by working in partnership and cooperation with university researchers, environmental groups, and governmental agencies.

CURRENT RESEARCH

- **Damon Bassett** – Paleontology and General Physical Geography
- **Melanie Carden-Jessen** – Earth Science Education and Assessment
- **Toby Dogwiler** – Applied GIS and 3D Imaging, Geomorphology, Hydroclimatology, Water Resources
- **Kevin Evans** – Meteorite Impact studies, syntectonic sedimentation and sysedimentary deformation, carbonate depositional systems and stratigraphy, coastal change and tectonism in Jamaica, cultural geology, geological mapping, Antarctic geology
- **Krista Evans** – Rural planning, rural gentrification, tiny house movement, historic preservation
- **Emily Frazier** – Cultural and political geography, Migration, refugees and displacement, Borders, place and identity, Geographies of (un)welcome and belonging, Building sustainable communities, Religion and civil society
- **Melida Gutierrez** – Geochemistry of sediments contaminated with mining wastes, Groundwater quality, water-rock interactions, Sustainability of groundwater resources, Environmental education
- **Evan Iacobucci** – Attitudes, Communication processes, Social forces, Transportation planning, Travel behavior, Urban freight
- **Asif Ishtiaque** – Climate change adaptation, vulnerability, and resilience, Climate change and agriculture, Sustainable development, Land use land cover change, Environmental justice, Environmental governance
- **Tasnuba Jerin** – Fluvial geomorphology, Biomorphology, Watershed Hydromorphology, anthropogenic and climate change impacts on fluvial systems and watersheds, sustainable watershed management
- **Bernard Kitheka** – Sustainable travel and tourism, community engagement for sustainability, urban transitions
- **Jun Luo** - Geographic Information Science, Spatial analysis and modeling
- **Ron Malega** – Social geography, urban affairs and planning, residential segregation, policing
- **Matt McKay** – Field geology, Tectonics, Structural geology, Clastic and volcanic stratigraphy, Metamorphic petrology, Spatial learning
- **Xin Miao** – Remote Sensing, Deep learning, Photogrammetry, LiDAR, Cryosphere, Vegetation monitoring
- **Gary Michelfelder** - Volcanology, Igneous Petrology, Geochemistry
- **Kevin Mickus** – Applied geophysics-tectonics, Mineral exploration, Environmental geophysics, Geothermal exploration
- **David Perkins** – Tourism geography, Sustainable development, Biometeorology, Economic Geography, Weather, Climate, and Society
- **Matthew Pierson** – Mechanically Stabilized Earth (MSE) structures, load testing foundations, and computer simulation of geomaterials or rivers
- **Xiaomin Qiu** – Graphical Representation of Spatial Data

2024 CNAS UNDERGRADUATE RESEARCH SYMPOSIUM WINNERS WITH FACULTY ADVISORS

Biology: Ecology, Wildlife and Conservation

1st Place: *Tabitha Moul, Moth Castagna, Maggy Mayberry, Krista Cockrum, Kendra Edge, James Bynum, Avery Russell*
YOU'RE POLLEN MY LEG! POLLEN SPECIALIZATION VARIES LITTLE ACROSS BUMBLE BEE SPECIES AND PRAIRIES
Faculty Advisor: Avery Russell

2nd Place: *Leo Carpenter*
A NEW SPECIES OF HESPEROCHERNES (PSEUDOSCORPIONES: CHERNETIDAE) IN OREGON FROM BURROWS OF MOUNTAIN BEAVER (MAMMALIA: APLODONTIDAE: APLODONTIA RUFA)
Faculty Advisor: Charles D. R. Stephen

Biology: Cellular, Microbiology and Genetics

1st Place: *Emma Goodwyn, Sophia Antonopoulos*
IDENTIFICATION OF SPRING SEASON FRESHWATER BIOFOULING ORGANISMS ON FLEXIBLE SENSOR SUBSTRATES
Faculty Advisor: Paul Durham

2nd Place: *Daniela Silva Torres, Sophia Antonopoulos*
METHOD FOR CRYOPRESERVATION OF SPINAL CORD TISSUE FOR ESTABLISHING PRIMARY CULTURES OF NEURONS AND GLIA
Faculty Advisor: Paul Durham

Chemistry and Biochemistry

1st Place: *Victoria Ogbeifun, Caitlin M. Padgett & Natasha DeVore*
PROTEIN CHARACTERIZATION AND CRYSTAL STRUCTURE OF YELLOW THERMOSTABLE PROTEIN (YTP) Q66E E148D
Faculty Advisor: Natasha DeVore

2nd Place: *Clayton Frazier, Santimukul Santra, Paris Yates, Elizabeth Bowie, Megan Liermann, David Johnson and Tuhina Banerjee*
MEMBRANE FUSION INTERACTIONS OF ENVELOPED VIRUSES USING MAGNETICALLY-

LABELED LIPOSOMES
Faculty Advisor: Tuhina Banerjee

Computer Science

1st Place: *Tony Enrique Astuhuaman Davila*
INCREASING EXPLAINABILITY OF DIMENSION REDUCTION METHODS FOR MACHINE LEARNING OUTCOMES
Faculty Advisor: Dr. Tayo Obafemi-Ajayi

2nd Place: *Dorian Morrissey*
UAV ATTACKS DETECTION USING DEEP LEARNING
Faculty Advisor: Dr. Mohammed Yassine Belkhouche

Cooperative Engineering

1st Place: *Jack Stone, Braxton Hall, Nicholas Winn, Nicholas Stogsdill*
AUTOMATED LOAD FRAME
Faculty Advisors: Dr. Matthew Pierson and Dr. Rohit Dua

2nd Place: *Nathaniel Van Devender, Michael Hardesty, Aaron Frater, Gabriel Fedynich*
PADDLE OBSOLESCENT NOVELTY KNOCK-OFF (PONK)
Faculty Advisor: Dr. Rohit Dua

Geology

1st Place: *Madalyn Bass*
EVOLUTION OF PLANT HARDINESS ZONES IN MISSOURI 1946 – 2015
Faculty Advisor: Toby Dogwiler

Geography, Geospatial and Planning

1st Place: *Sarah Tuck*
NOT TOO SMALL TO MAKE A DIFFERENCE: NATURAL RESOURCE EDUCATION IN ZAMBIAN PRIMARY SCHOOLS
Faculty Advisor: Asif Ishtiaque

2nd Place: *Ryan Griffin, Morgan Harriman, Ben Holland*
NAVIGATING CHANGE: UNDERSTANDING PUBLIC PERCEPTION OF URBAN REDEVELOPMENT AT A BUSY STREET CORNER OF A HISTORIC NEIGHBORHOOD
Faculty Advisor: Ron Malega

Mathematics

1st Place: *Rachel Lee*
THE PRODUCT OF THE CHROMATIC NUMBER AND INDEPENDENCE NUMBER OF A GRAPH
Faculty advisor: Dr. Les Reid

2nd Place: *Christopher Housholder*
EXPLICIT REPEATED DOT PRODUCT TREE CONSTRUCTIONS
Faculty Advisor: Steven Senger

Physics, Astronomy and Materials Science

1st Place: *Simarpreet K. Girn, Sarah J. Morrison, Caroline Witt, Mateo E. Guerra Toro*
OUTCOMES OF SUPER-EARTH FORMATION IN THE PRESENCE OF A JUPITER-LIKE PLANET
Faculty Advisor: Sarah Morrison

2nd Place: *Yashasvi Moon*
SOUTH POLE TELESCOPE'S DUTY CYCLE FOR TRANSIENT SCIENCE
Faculty Advisor: Prof. Joaquin Vieira (University of Illinois at Urbana-Champaign)