15th ANNUAL CNAS UNDERGRADUATE SYMPOSIUM

THURSDAY, APRIL 25, 2024

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. Deb Finn,
Department of
Biology

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CNAS *Administration*

Tamera Jahnke, Dean

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Guest Speaker Dr. Deb Finn is the 2023 recipient of the Atwood Research and Teaching Award and an Associate Professor in the Department of Biology

"Wow" moments in science, with some examples from stream ecology

Abstract:
The seemingly impractical but ultimately pivotal role of what I'll call the "wow factor" in science has been largely neglected in recent years. I think it's important to bring the importance of the "wow!" back to the forefront, particularly in terms of choosing career paths with great potential to be fulfilling. I'll share some examples of how the wow factor inspires novel questions and study designs in my stream ecology research group at MSU, with an emphasis on a broad question that is particularly relevant to Ozark streams: How can so much biodiversity be maintained in ecosystems that frequently experience major disturbance in the form of floods and drying?

About Dr. Deb Finn: Dr. Finn is a stream ecologist and has been in the Biology Department at MSU since 2017. She loves discovering novel "wow" things about stream ecosystems through the scientific method and empirical ("real life", in the field) study designs, then communicating the discoveries by giving presentations at conferences and publishing written accounts, primarily in the form of scientific papers. She also thrives on collaboration in research, especially with students. She says there is nothing more "wow" than making novel discoveries with fun collaborators, from undergraduates at MSU to experts from around the globe. All streams have wow factors, and the fantastic spring-fed but flashy Ozark streams right here in SW Missouri have never yet failed to blow her mind. She has mentored many student-led projects in Ozark streams that have produced new ecological insights, and she is forever grateful for all the enthusiastic, smart, and fun students she's gotten to work with so far at MSU.
(Note a new "Mind's Eye" piece on Dr. Finn and her students in Ozark streams: https://blogs.missouristate.edu/mindseye/deciphering-the-disturbances/)

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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#1 - NITRATE-PROVIDING SPECIES *AZOLLA* A SOURCE OF NITROGEN IN LAKE SPRINGFIELD

Anna Faust. Biology, Faculty Advisor: La Toya Kissoon-Charles

Azolla sp. (mosquito ferns) are fast-growing, floating aquatic ferns that form mats on quiet waters in temperate and tropical regions. Two species (*Azolla microphylla* and *Azolla caroliniana*) are native to Missouri but are not common in the state. *Azolla* species are known for their symbiotic relationship with the nitrogen-fixing cyanobacteria, *Anabaena azollae Strasburger*. This symbiotic relationship promotes *Azolla* growth and enriches waters with nitrates, leading to algal blooms. *Azolla* is problematic because it negatively impacts water quality, native plants, and amphibian larvae. We observed *Azolla* outside of its known range in Lake Springfield (Springfield, Missouri) in fall 2020 and in subsequent years we observed it spreading to other parts of the lake. The US EPA listed Lake Springfield as impaired due to high algal abundance caused by excess nutrients. *Azolla* in Lake Springfield can compound this problem since it releases nitrates upon decomposition. We are monitoring Lake Springfield every 2-3 months to assess the abundance of *Azolla*. To determine the impacts of *Azolla* abundance, we will measure nitrate concentrations and algal abundance inside and outside of *Azolla* mats. Our findings will help us understand *Azolla*'s impacts to Lake Springfield's water quality and can help with developing effective management strategies

#2 - EVALUATING VARIABLES FOR CHARACTERIZING HYPORHEIC INVERTEBRATE COMMUNITIES IN OZARK STREAMS

Connor Bruemmer. Biology. Faculty Advisor: Deb Finn

Ozark streams are complex habitats of high biodiversity. A substantial proportion of the biodiversity that fuels complex food webs come from invertebrates found under the streambed, in the hyporheic zone. A common method to sample hyporheic invertebrates is by hammering a large driver to insert PVC wells into the sediment, then pumping water from a known depth. The hammering could generate a local disturbance which would impact the accurate description of the community. Previously, we have tested how long to wait before pumping a well so that the disturbance of hammering can be negated, and one week had been deemed necessary. However, our study design included only samples collected immediately and a week after hammering the wells, neglecting a control for natural changes in community structure that might occur through a week. In October 2023, we repeated the study, this time installing and immediately pumping wells at both time periods. Data processing is still ongoing, and I will present preliminary results in comparison to results from the earlier study. Identifying methods to accurately describe the hyporheic invertebrate community is important, given its as-yet vastly underappreciated role in supporting iconic stream animals like fish, birds, and bats.

#3 – EVALUATING THE RELATIONSHIP BETWEEN HYPORHEIC INSECT BIOMASS AND FINE SEDIMENTS IN STREAMS

Mackenzie Childers, Jackson Winslow, Alexis Reifsteck. Biology. Faculty Advisor: Debra Finn

In streams, the hyporheic zone provides habitat for diverse invertebrates including insects. These insects emerge as adults, becoming important food sources for fish and other predators. Ozark streams have coarse gravel beds but can have varying amounts of fine sediment. We sampled 6 comparably sized streams on two dates, April (high-flow season) and July (base-flow) to assess whether the percentage of fine sediments (%fines) in the hyporheic zone was associated with the standing biomass of hyporheic insects. To quantify %fines, we collected 6 replicate cores ~40 cm deep into the streambed then dried and sieved the sediment to obtain the percent dry mass of particles <0.5mm. To collect invertebrates, we pumped 8 liters of hyporheic water from each of the 6 replicate locations per stream/date and estimated biomass of the insect component by using published length-mass relationships. Across these streams %fines ranged from 1.4%-9.5%. Overall results show a negative relationship between %fines and insect biomass, despite taxonomic differences between the two seasons. Increased fine sediments in gravel beds likely reduce interstitial space for larger-bodied insects and restrict insects with certain movement types like crawling or swimming. Our results could have implications for watershed management.

#4 - STREAM SOURCE AFFECTS AQUATIC INSECT COMMUNITY STRUCTURE AND BIODIVERSITY IN THE TROPICAL HIGH ANDES

Brynn Kayhill. Biology. Faculty Advisor: Dr. Deb Finn

High-elevation streams have heterogeneous water sources that can strongly impact biodiversity patterns. In the tropical Andes, there are two major water sources: glacier runoff and groundwater springs. Glacier-fed streams have flashy, unpredictable flows, while groundwater-fed streams have more stable conditions. We asked how biodiversity patterns of macroinvertebrates in streams on the high volcano Cotopaxi (Ecuador) varied with these contrasting water sources. We collected macroinvertebrates from three paired groundwater and glacier-fed streams, nine times through a full year. Each stream pair shared a common watershed and converged downstream of our sample locations. After sorting, identifying, and counting the collected macroinvertebrates, we found that the groundwater-fed streams had greater taxa richness and abundance than glacier-fed streams, as well as greater stability of community structure through time. Climate change threatens glaciers and the streams they source, but if groundwater streams persist, they could be a refuge for a sizable proportion of macroinvertebrate diversity in the tropical Andean cryosphere.

#5 - POTENTIAL INVASIVENESS OF FAXONIUS LONGIDIGITUS IN THE ELK RIVER, MISSOURI WATERSHED

Alexis Ives, Alia Ramirez, and Jonny Pollard. Biology. OTC Faculty Advisor: Keith Jones

Crayfish are found around the world in a variety of habitats where they support complex food webs. Due to their large size, high fecundity and lentic, terrestrial and generalist habitat preferences they have the potential to be invasive in new ecosystems. Their effect is compounded by their importance to the food webs in the streams and drainages they inhabit. *Faxonius longidigitus,* common name: Longpincered crayfish, is a species of crayfish endemic to the White River drainage in Arkansas and Missouri. However, they have been identified in the nearby Elk River drainage, raising concerns about their potential to disrupt native ecosystems. In this analysis, we present information regarding the potential invasiveness of *F. longidigitus*; however, there are a number of questions, including the ability of F. longidigitus to outcompete native species and the impact they will have on the native Elk River system.

#6 – ANTIBACTERIAL RESISTANCE IN CONSERVATION AREA SOIL

Kristopher Lopez. Biology. OTC Faculty Advisor: Keith Jones

Being able to treat livestock with antibiotics helps keep them healthy, but there are consequences to the liberal use of antibiotics. Bacteria can obtain resistance to these antibiotics and potentially cause untreatable infections. Antibiotics can leech into waterways and inevitably make their way into the soil. The purpose of this experiment is to test the antibacterial resistance of bacteria in soil around the Springfield area to understand the consequences of overuse of antibacterials. A sample was collected from Wire Road Conservation Area and diluted via serial dilution then plated on MacConkey agar with varying concentrations of tetracycline, a commonly used antibiotic. After incubation, colonies were counted to determine the amount of antibiotic resistant colonies per gram of soil. The average percentage of antibiotic resistant cells was about 1.21% in the 3µg/mL tetracycline (Tet3) and about 0.13% in the 30µg/mL tetracycline (Tet30). This isn't a significant percentage compared to others that have been done around the country, but the Tet3 percentage is slightly higher than the samples taken within 100 miles of Springfield, MO. More samples need to be taken and analyzed to give a statistically accurate estimate of the prevalence of antibiotic resistant bacteria in soil around the Springfield area.

#7 - AN ANALYSIS AND COMPARISON OF THE SOUNDSCAPES AT TWO SITES AT BIG SUGAR CREEK STATE PARK

Makayla Miller, Charidy McKinzie. Biology. OTC Faculty Advisor: Keith Jones

Recorders (Wildlife Acoustics Song Meter Mini, Song Meter Micro) were deployed at Big Sugar Creek State Park to gather data on the soundscape. Two separate communities were evaluated. Data revealed a dynamic soundscape that varied depending on the season and was affected by the plant communities in the sites.

#8 – A FIELD STUDY OF THE OCCURRENCE OF BATRACHOCHYTRIUM DENDROBATIDIS IN THE OZARK HIGHLANDS ECOREGION.

Kara Montgomery, Aislinn Wilson, and Jesse Kinney. Biology. OTC Faculty Advisor: Keith Jones

Salamanders are enigmatic creatures that are keystone species in the ecosystems they inhabit. They provide a number of ecosystem services, including insect population management and linking higher trophic level consumers to lower levels. Currently, many amphibian species are threatened and endangered, including Caudates(1). These threats include the rise in pests, and spread of infectious diseases, such as *Batrachochytrium dendrobatidis* and *B. salamandrivorans* (hereafter Bd and Bsal). In Fall of 2023, we used adaptive sampling techniques to locate salamanders at Big Sugar Creek State Park in order to determine the occurrence of Bd and Bsal in the Western Ozarks ecoregion. We located these salamanders within their habitats, captured them by hand and swabbed them according to the SNAP guidelines. Swabs were sent to the USGS National Wildlife Center in Madison, Wisconsin where polymerase chain reactions were performed to identify Bd and Bsal. There were 51 salamanders observed, 21 were swabbed, and 19 swabs were sent in for testing. All tests were negative for both *B. dendrobatidis* and *B. salamandrivorans*.

#9 - YOU'RE POLLEN MY LEG! POLLEN SPECIALIZATION VARIES LITTLE ACROSS BUMBLE BEE SPECIES AND PRAIRIES

Tabitha Moul, Moth Castagna, Maggy Mayberry, Krista Cockrum, Kendra Edge, James Bynum, Avery Russell. Biology. Faculty Advisor: Avery Russell

Remnant tallgrass prairies contain diverse plant species thought to be essential to bumblebee populations. While bumblebees must collect protein-rich pollen to survive, not all plants offer high quality pollen. Consequently, bumblebees often specialize on a subset of available plant species. Yet how specialization is affected by flower biodiversity and varies among co-occurring bumblebees species is not well understood. We therefore examined pollen specialization for 6 sympatric bumblebee species across 6 remnant prairies in Southwest Missouri in 2022 and 2023. Furthermore, we characterized flower abundance and diversity for each prairie. Using microscopy, for each bee, we counted and characterized morphological types of pollen as common or rare. We found that the number of rare, but not common pollen types per bee, differed among bee species. For one species with sufficient data, *Bombus griseocollis*, no difference in specialization among prairies occurred, despite large differences in flower biodiversity among prairies. Finally, the number of rare, but not common pollen types increased with more pollen collection, suggesting bees visit more flower species over time, but not to collect pollen. Overall, our results suggest sympatric bumblebee species have similar foraging behavior and therefore that conservation efforts directed at one species may benefit all co-occurring species.

#10 – A NEW SPECIES OF *HESPEROCHERNES* (PSEUDOSCORPIONES: CHERNETIDAE) IN OREGON FROM BURROWS OF MOUNTAIN BEAVER (MAMMALIA: APLODONTIDAE: *APLODONTIA RUFA*)

Leo Carpenter. Biology. Faculty Advisor: Charles D. R. Stephen

Shallow subterranean arthropod collections in Oregon from Mountain Beaver (Mammalia: Aplodontidae: *Aplodontia rufa*) burrows for ectoparasites resulted in what we determined to be an undescribed pseudoscorpion species in the genus *Hesperochernes* (Chernetidae). The collections included 488 individuals: 129 males, 71 females, including 17 with egg sacs, and 289 nymphs. Specimens were collected on four different collection dates: 16 December 1981, 19 July 1982, 14 August 1982, and 17 August 1982. This new species is separated from its congeners by an apophysis on the dorsal surface of the chela hand present in males and females, measurements of the pedipalps, placement of movable finger trichobothria, and chela length. The genus *Hesperochernes* includes 21 described species, including two cave-obligate species *H. mirabilis* and *H. bradybaughi*; however, the undescribed species does not have troglomorphic morphology. The geographically closest known surface-inhabiting Hersperochernes is *H. montanus*; however, the males do not have a chelal apophysis, and their body measurements differ. We provide a complete species description that includes illustrations of both sexes, immature stages, and egg sacs; measurements; and a diagnostic key separating the new species from those described. Notes are also provided on potential interactions with Mountain Beaver and other potential burrowing mammals.

#11 – DOES A TOTAL SOLAR ECLIPSE ELICIT BEHAVIORAL RESPONSES IN BATS? AN ACOUSTIC SURVEY

Bradley Bateman and Giorgia Auteri. Biology. Faculty Advisor: Giorgia Auteri

Solar eclipses draw global attention, not only from humans, but also other animals. However, due to the rarity of these astronomical events, there is little research into the effects of eclipses on animal behavior, although many crepuscular species have been shown to alter their activity during eclipse events. I have taken advantage of this rare phenomena in an attempt to understand how one such species—bats—may be affected. Ultrasonic acoustic recorders were deployed during the April 8th solar eclipse to passively record sounds of big brown bats (*Eptesicus fuscus*) in their roosts. Two roosts in the path of totality were sampled, with one located in Missouri and the other in Indiana. Call recordings were analyzed to compare social calls before, during, and following the eclipse. Implications of this study can be applied to understanding the environmental cues that cause bats to interrupt normal torpor/hibernation (for instance, understanding the degree to which environmental cues can override circadian rhythms). I hope this study will spark curiosity to further study these rare phenomena and their effects on bats.

#12 – IMPACT OF BIOMETRICS ON BAT EXPLORATION BEHAVIOR

Josey McChesney. Biology. Faculty Advisor: Georgia Auteri

Animal behavior is closely linked to their ecology. Understanding within-species variation in behavior can help ascertain demographic-specific strategies for dealing with their environment. We sought to assess if there were intraspecific behavioral differences among gray bats (*Myotis grisescens)*—an endangered species of bat which occurs in Missouri. We hypothesized that males and adults would exhibit more aggressive behaviors compared to females and juveniles. During fall-spring of 2022 and 2023, we captured bats in the wild, placed them in a behavioral maze (representing a novel environment), then recorded bats via thermal video to observe exploration behavior during 2.5-minute trials. Recordings were later watched to quantify head sweeping/bobbing and arm probing while in the maze. We expected probing and head-bobbing to be proxies for non-aggressiveness, and for females and juveniles to have more of these actions. We observed that juveniles exhibited both more head bobbing and more probing compared to adults, but females did not show a significant difference from males. Our findings bring into question whether these behaviors are truly indicative of non-aggression in bats. Alternatively, these behaviors may indicate comfort or life experience.

#13 - EVALUATING FISH ASSEMBLAGES AND BROOK TROUT POPULATION CHARACTERISTICS THROUGHOUT THE PLOVER RIVER, WISCONSIN

Jackson Donato. Biology. Faculty Advisor: Quinton Phelps

The Wisconsin Department of Natural Resources (DNR) conducts trout surveys on the headwaters of the Plover River but rarely surveys the middle and lower reaches. Given the lack of sampling effort and knowledge, we sought to quantify differences in fish assemblages and Brook Trout *Salvelinus fontinalis* population characteristics longitudinally to better inform management decisions. We used backpack and barge electrofishing to sample three reaches of the Plover River (lower, middle, and headwaters). Longitudinal differences in community composition were analyzed using catch per unit of effort (CPUE) for cold water, cool water, and eurythermal species. Proportional size distribution (PSD), CPUE, and relative weight (Wr) were used to quantify population characteristics of Brook Trout. The results agreed with the river continuum concept. Cold water and cool water species were shown to have higher abundance in the headwaters and eurythermal species were shown to have higher abundance in the lower reaches. Brook Trout abundances were highest upstream and declined downstream with none collected in the lower reaches. However, PSD suggested a smaller size structure in the headwaters (i.e., more abundant) and larger individuals in the middle reaches.

#14 - THE EFFECTS OF REGOLITH TO AMENDMENT RATIO MEDIUMS ON PLANT GROWTH OF THE ROYAL PURPLE RADISH PLANT

Austin Brown and Raven Brown. Biology. Faculty Advisor: Dr. Kovacs

Gaining access to edible food off the Earth's surface is a vital piece in space exploration and colonization. The ability to grow food successfully with as little of Earth's soil or resources is also ideal, as it strengthens our abilities as an interplanetary species. As a progressive species and society, we face many challenges in overcoming this feat, from water, light, and nutrient supply to even storage of such things. While storage is less of an issue in the long run, it is the water, nutrients, and light that become the biggest obstacles in achieving agriculture in space. This is what my team worked with, in an attempt to find an innovative way to supply these to the Royal Purple radish plant- a quick-growing root plant high in vitamins that are important in the Human diet. We worked with LHS-1 Lunar Highland regolith simulant from the Exolith Laboratory in Florida, United States, to regulate and test the growth of the plants in their manipulated soil makeup in accordance to the ratio of the mediums that they were placed in. The plants were placed in an environment similar to what they would experience on the ISS or a lunar station, and the variables such as light and water, were kept constant.

#15 - DEFENSE RESPONSE OF *VITIS RUPESTRIS* INDUCED BY THE INSECTICIDE CARBARYL

Michael Bigelow, Katelin Meek. Biology. Faculty Advisor: Laszlo Kovacs

Carbaryl is an insecticide used for pest control on grapevine. We repeatedly observed the occurrence of interveinal leaf necrosis following carbaryl spray application in an F1 hybrid progeny under both Missouri and New York field conditions. RNA-seq analysis at three different time points post-treatment revealed a significant increase in the expression of key immune regulators *EDS1* and *SAG101,* which are part of the salicylic acid-mediated defense pathway and hypersensitive reaction. Interestingly, the expression of several defense-related genes was also upregulated. For example, the expression of jasmonate-induced oxidase 1 and ethylene-response factor C3 increased. Insensitive plant changes in gene expression occurred primarily 24 hours post-treatment, after which they regressed to baseline. This pattern led us to conclude that sensitive plants experience carbaryl exposure as a stressor. Previous QTL analyses repeatedly mapped this trait to chromosome 16 of the female parent; however, none of the transcriptionally upregulated genes mapped to this location. We hypothesize that this region may encode a receptor that mistakes carbaryl for a pathogen-associated molecular pattern and activates a defense response which leads to a hypersensitive reaction.

#16 - PREVALENCE OF ANTIBIOTIC-RESISTANT BACTERIA WITHIN THE ENVIRONMENT

Gypsy Pitts, Catalina McCoy. Biology. Faculty Advisor: Mr. Richard Wells

Our project assesses the 'Prevalence of Antibiotic-Resistance in the Environment' (or PARE). Two soil samples were collected, one from a dry region (36.09409°N, 115.02655°W) and one from a coastal region (27.92477°N, 97.18041°W). After this, three different types of plates were made; Tet3 (MacConkey agar + Amphotericin B (10µg/ml) + Tetracycline (3µg/ml)), Tet30 (MacConkey agar + Amphotericin B (10µg/ml) + Tetracycline (30µg/ml)), and NA (MacConkey agar + Amphotericin B (10µg/ml)). The following serial dilutions were performed to the soil samples, 1/10^1, 1/10^2, 1/10^3, 1/10^4, 1/10^5, respectively. For the NA plates, 1/10^1 through 1/10^5 was plated. For both Tetracycline plates 1/10^1 through 1/10^3 was plated. For each plate, 0.1 ml of the solution was plated on each plate. All plates were wrapped in parafilm and incubated at room temperature. The data of our results seems to suggest that coastal regions have exponentially higher amounts of gram negative antibiotic resistant bacteria than the dry regions tested.

#17 – TREATMENT OF NANOPARTICLES HINDERS DOWNREGULATION OF TRANSMEMBRANE TRANSPORTERS

Emma Braun, Nhi Le, Dr. Kyoungtae Kim. Biology. Faculty Advisor: Kyoungtae Kim

Quantum dots are a type of nanoparticle with semiconductive and fluorescent properties. Due to their unique properties, QDs have applications in cell imaging, drug delivery, cancer research, and many other biological disciplines. Although QDs are very versatile, recent studies have shown that they are toxic to cells. The mechanisms of their toxicity are not widely known so research to determine and understand QD toxicity is important in the development of safer alternatives. QDs have been shown to interact with many different proteins such as transmembrane transport proteins. In this study, QDs were applied, 25 µg, to *Saccharomyces cerevisiae* containing Can1-GFP and Ste2-GFP. The cells were then incubated for 6 hours and visualized using a confocal microscope. In the cells containing Can1-GFP, upon treatment of QDs, the transmembrane proteins stayed at the membrane. In the control group, Can1-GFP was targeted to the vacuole for recycling. In the cells containing Ste2-GFP the control and treated group had no significant difference. These results were determined by taking the membrane to vacuolar fluorescent intensity. These results suggest that certain amino acid sequences found within the cytosolic terminal of transmembrane proteins may be interacting with QDs. These sequences may not be present in every transport protein given that Ste2-GFP behaved differently than Can1-GFP upon treatment of QDs. Now that we know QDs have a significant effect on Can1-GFP downregulation we can investigate how QDs interact with ubiquitin, which tags proteins for degradation at the vacuole.

#18 - QUANTUM DOTS ALTER ACTIN DYNAMICS

Abhishu Chand, Nhi Le. Biology. Faculty advisor: Dr. Kyoungtae Kim

Quantum dots (QDs) are biocompatible nanoparticles that are highly sought after for their potential in biomedical applications such as drug delivery due to their unique optical and electronic properties. Even with such immense potential, the use of QDs in biological settings has been limited due to concerns regarding their toxicity in the cell. Our previous studies revealed that QDs interact with G-actin and impair its function. Therefore, we further investigated the effects of QDs on the actin dynamics using several biomolecular techniques. Our results revealed that QDs behave in a biphasic manner in the actin assembly process, where high concentrations of QDs inhibit actin polymerization while the lower concentrations of QDs stimulate actin polymerization. We also found that the QDs bind to F-actin and cause enhanced depolymerization of the actin filament and can also cause the bundling of the filaments. These effects of QDs highlight the importance for safer QDs in order to minimize their toxicity and optimize their potential usage in the biomedical fields.

#19 - INTERNALIZATION OF QUANTUM DOTS RESULT IN DESTRUCTIVE DETACHMENT OF HUMAN LIVER CELLS

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

Quantum dots (QDs) are a variant of semiconducting nanoparticles with great biomedical potential, as they possess the ability to fluoresce or act as a means of drug delivery. A caveat to their biomedical potential is their cytotoxicity. We studied the interaction of cadmium selenide zinc sulfide quantum dots (CdSe/ZnS QDs) on transformed human liver epithelial-2 cells (THLE-2). Upon treatment of QDs, a morphological change was observed in cells, as they lost their attachment spindles. We subsequently examined how QDs interact with F-actin as cytoskeletal protein F-actin is observed to be distributed throughout the cell and its attachment spindles. We found cells treated with QDs to result in significant F-actin rearrangement. Overall, our study has shown that quantum dots interact with F-actin and can result in morphological changes that are associated with detachment.

#20 - FROM KITCHEN TO LIVER: THE TOXIC CONNECTION OF PFOS IN NON-STICK COOKWARE

Phuong Tran, Dr. Kyoungtae Kim. Biology. Faculty Advisor: Kyoungtae Kim

Perfluorooctane sulfonate (PFOS) is a widely detected environmental pollutant that has drawn increasing attention due to potential health risks. Despite its widespread distribution, the exact mechanism of its toxicity is yet to be fully understood. To investigate the hepatic effects of PFOS, our study utilized HepG2 and THLE-2 cell models to replicate conditions reflecting PFOS accumulating in the liver. Three assays were conducted to assess the toxicological interactions of the chemical on both cell lines including cell viability, cell stress and cell death. The XTT viability assay results demonstrated a dose-dependent decrease in the number of viable cells when treated with increasing concentrations of PFOS. The IC50 values were approximately 100 micromolar, which elevated reactive oxygen species (ROS) in both cell lines. PFOS exposure also led to increased apoptotic levels, as evidenced by the upregulation of Caspase-3 activity. Our future goal includes RNA sequencing, rt-qPCR as well as metabolomic profiling of PFOS-exposed HepG2 and THLE-2 cells, providing comprehensive understanding of the chemical's impacts on hepatic cellular metabolism.

#21 - GROWTH AND MORBIDITY AMONG 6^{TH} – 7^{TH} GRADE STUDENTS IN EASTERN & SOUTHERN PROVINCES OF ZAMBIA.

F. Rodriguez Lopez, Dr. M. Willis, CNAS, Biology. Faculty Advisor: Dr. M .Willis

Previous studies in Africa have found evidence of stunting in children as well as correlations with infectious diseases. This study was designed to determine if Zambian primary school children fit the growth and disease patterns found in other African countries. Sample included 938 anthropometric assessments and interviews with 6-7^{th} grade students from 5 schools, 10-21 years old, in Eastern Province, city of Chipata, and Southern Province, city of Livingstone. Data hand-written in composition notebooks and entered into Excel. Descriptive and correlational analyses conducted in Excel after anthropometric data were assessed using WHO Anthro Plus software. In total, 74 students fit the WHO definition for stunting (HAZ= $x < -2$) while 602 students were short for their age (HAZ= $-2 < x < 0$). Of all morbidities, a Upper Respiratory Disease is the most reported of all disease types (77%) Children in the Eastern Province are shorter for their age than those not. Supported by Benjamin A. Gilman – McCain Scholarship, MSU Board of Governors and College of Natural and Applied Sciences at MSU.

#22 - DISCREPANCIES IN *ESCHERICHIA COLI* DETECTION: A STUDY ON FECAL CONTAMINATION USING IDEXX AND EOSIN-METHYLENE BLUE (EMB) AGAR.

Mercedez Hanlon, Jackson David. Biology Faculty Advisor: Babur Mirza

More than 50% of freshwater resources within the USA have been classified as bacterially impaired systems due to the presence of *E.coli* and fecal coliforms. Frequently, the presence of *E.coli* and fecal coliforms in water samples is tested using IDEXX plates. IDEXX testing is quick and inexpensive, allowing for the rapid identification of potential health risks associated with water use. This method has been useful in reducing the number of infections related to waterborne pathogens. However, sometimes these methods may not be accurate. In this study, we aim to test if any false positives have been detected through IDEXX testing. We isolated positive wells from IDEXX plates and plated them on EMB agar. *E.coli* produces metallic sheen green colonies on EMB. Both tests rely on the presence of specific genes known to be housed by *E. coli*, yet there are discrepancies between these two commonly used tests. We determined that some species of bacteria present a positive result on one test but not the other, which could indicate either a false positive result or specify a potential novel identification of *E. coli* strains. We are further identifying these bacterial isolates through 16S rRNA gene sequencing

#23 - CHARACTERIZING NODULE ENDOPHYTE COMMUNITIES IN GLYCINE MAX USING NEXT-GENERATION SEQUENCING USING NEXT-GENERATION SEQUENCING

Erin Harrelson, Scott McElveen, Dr. Micheal Burton, Dr. Babur Mirza. Biology. Faculty Advisor: Babur Mirza

Biological nitrogen fixation (BNF) by rhizobial endophytes is one of the main sources of nitrogen for legumes. The efficiency of BNF relies on the selection of rhizobial endophytes with soybean root nodules. The selection of rhizobial endophytes in root nodules can be influenced by several biotic and abiotic factors. In the current greenhouse study, we explored the potential influence of organic matter and previous crop rotation practices on the selection of rhizobial endophytes within soybean root nodules. We used Illumina paired-end DNA sequencing of 16S rRNA and nifH gene amplicons to assess the bacterial diversity within soybean root nodules and rhizosphere soil. The results of 16S rRNA gene sequencing suggested that there was no direct influence of preceding crop and compost amendment on the selection of rhizobial endophytes with soybean root nodules. In all treatments, Bradyrhizobium spp. were the dominant rhizobial symbionts. These sequences were also used to make a phylogenic tree. Likewise, we also observed high abundance of Bradyrhizobium based on nifH gene sequencing. This suggests a strong role of the host plant in the selection of endophytes.

#24 - IDENTIFICATION OF SPRING SEASON FRESHWATER BIOFOULING ORGANISMS ON FLEXIBLE SENSOR SUBSTRATES

Emma Goodwyn, Sophia Antonopoulos. Biology Department/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

There is an increasing demand for development of sensors that continuously monitor freshwater safety and quality. Developing sensors with flexible substrates is of interest due to their malleability, cost effectiveness, and durability. The accuracy and performance of submerged water sensors for extended times can be greatly reduced by biofouling. The goal of this study was to identify via 16S and 18S rRNA next generation sequencing (NGS) prokaryotic and eukaryotic microorganisms adhering to submerged flexible substrates. The substrates cyclic olefin copolymer (COC) and polyethylene terephthalate (PET) were suspended in aquariums filled with river or pond water from the Springfield, MO region collected during April and maintained at 60°F to simulate spring conditions. Isolated DNA was used for NGS analysis to identify adherent microorganisms and determine relative abundance. The most prevalent biofouling organisms were *Betaproteobacteria* in river water and pond water on both substrates. The species *R. aquatilis* and *P. saccharophila* were most abundant on COC in river water, while the species *A. tertiaricarbonis* and *Z. ramigera* were most abundant on COC and PET in pond water. Within higher taxonomic levels, there were negligible differences in abundance between the biofouling organisms on COC and PET substrates and in river and pond water.

#25 - IDENTIFICATION OF WINTER FRESHWATER BIOFOULING ORGANISMS ON FLEXIBLE SENSOR SUBSTRATES

Emma Loder, Sophia Antonopoulos. Biology Department/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

There is an increasing demand for development of sensors that continuously monitor freshwater safety and quality. Developing sensors with flexible substrates is of interest due to their malleability, cost-effectiveness, and durability. The accuracy and performance of sensors submerged in water for long times can be greatly reduced by biofouling. The goal of this study was to identify via next generation sequencing (NGS) the 16S and 18S rRNA gene sequences of prokaryotic and eukaryotic microorganisms that adhered to submerged flexible substrates in freshwater samples obtained in January 2023. Substrates cyclic olefin copolymer (COC) and polyethylene terephthalate (PET) were suspended in aquariums filled with river or pond water and maintained at 40-45°F to simulate winter conditions. No major differences in biofouling abundances between river and pond conditions nor COC and PET substrates were detected. The most prevalent taxonomic groups were the Bacteria followed by Fungi and Archaea. At the phylum level, Ascomycota and Proteobacteria were most abundant, followed by Firmicutes. *Neosartorya fischeri* was the most prevalent species. *Halarchaeum solikamskense*, a halophilic archaeon, was the second most abundant species. Future studies will be initiated to identify antifouling strategies that limit bacterial, fungal, and archaeal growth on flexible sensor substrates submerged in winter water.

#26 – ORAL PFOS EXPOSURE IS ASSOCIATED WITH GREATER DYSBIOSIS IN ADULT MALE SPRAGUE-DAWLEY RATS COMPARED TO CHANGES IN FEMALES

Emma Loder, Sophia Antonopoulos. Biology Department/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

Perfluorooctanesulfonic acid (PFOS) is commonly used in non-stick and stain-resistant consumer products, food packaging, fire-fighting foam, and industrial processes. PFOS resists degradation, persists in the environment, and is detected in drinking water. Oral PFOS exposure may alter the gut microbiota and cause dysbiosis, which is associated with many inflammatory human diseases. To investigate the effects of PFOS exposure on gut microbiota composition, adult male and female rats were exposed to PFOS via drinking water at a concentration of 0.5 µg/mL, 5 µg/mL, or only water for the duration of the 28-day study. Fecal samples were collected on days 0, 14, and 28. DNA was isolated, pooled, and next generation sequencing of 16S rRNA genes was performed. A significant decrease in weight occurred in PFOS exposed males at week 1 (5 µg/mL) and 2 (0.5 µg/mL), and in females at week 3 (5 µg/mL). The *Firmicutes* to *Bacteroides* (F/B) ratio, an indicator of dysbiosis, decreased in PFOS exposed males and increased in females at 0.5 µg/mL. The F/B ratio remained consistent in females exposed to 5 µg/mL PFOS. These findings suggest that oral PFOS exposure causes mild dysbiosis, particularly in males, females may have a protective mechanism against PFOS-induced dysbiosis.

#27 – CHARACTERIZATION OF CALCIUM CHANGES IN RESPONSE TO KCL STIMULATION IN PRIMARY CULTURES OF NEURONS AND GLIA FROM CRYOPRESERVED TRIGEMINAL GANGLIA: EFFECT OF NEURON-GLIA DENSITY

Nicole Nalley, Sophia Antonopoulos. Biology Department/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

Migraine and temporomandibular joint disorder are prevalent orofacial pain conditions characterized by activation of trigeminal ganglion (TG) neurons and glia. Elevated levels of intracellular calcium activate neurons and glia to release inflammatory mediators. Primary TG cultures provide a valuable cell model to identify therapeutic targets and investigate pathological mechanisms. However, most studies to date have investigated calcium changes using pure neuronal cultures and no studies have focused on changes in glia. Cryopreserved TG primary cultures from neonatal Sprague-Dawley rats were used to investigate the effects of neuron and glia density on intracellular calcium levels. Neuronal and glial enriched cell populations generated by density gradient centrifugation were plated on glass coverslips and incubated in 24 well plates. The fluorescent ratiometric dye Fura-2 was used to determine changes in intracellular calcium levels to 60 mM KCl. Calcium levels in response to KCl stimulation were much greater in enriched cultures when compared to mixed cell population cultures. In summary, the magnitude of the calcium increase is dependent on neuron-glia density and supports the notion that neurons modulate glial excitability while glia modulate neuronal excitability. Future studies will utilize TG cultures to investigate calcium changes in response to other inflammatory stimuli and anti-inflammatory agents.

#28 - METHOD FOR CRYOPRESERVATION OF TRIGEMINAL GANGLION FOR ESTABLISHING PRIMARY CULTURES OF NEURONS AND GLIA

Mikayla Scharnhorst, Sophia Antonopoulos. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

Primary cultures are used to elucidate cellular and molecular mechanisms involved in disease pathology and modulation by pharmaceuticals and nutraceuticals, and to identify novel therapeutic targets. However, preparation of primary neuronal and glial cultures from rodent embryos is labor-intensive, and it can be difficult to produce high-quality consistent cultures. To overcome these issues, our lab developed a simplified cryopreservation method for establishing rodent primary trigeminal ganglion neurons and glia from Sprague-Dawley neonates, using a 90:10 (v/v) fetal bovine serum/dimethyl sulfoxide cell freezing medium. The Live/Dead Cell Imaging assay was used to determine cell viability of the cultures and immunocytochemistry was used to characterize basal expression of proteins. Cryopreserved trigeminal ganglion cells stored for up to one year in liquid nitrogen retained high cell viability and exhibited similar neuronal (NeuN and β-tubulin) and glial cell (vimentin) morphology to fresh cultures. Cryopreserved cells were transiently transfected with reporter genes using the Lipofectamine P3000 Transfection Reagent, and relative light units measured in a luminometer using the luciferase and β-galactosidase assays. This is a simple method that does not require special reagents or equipment, saves time and money, increases flexibility in study design, and produces standardized, high-quality stocks of primary trigeminal ganglion cultures.

#29 - THE EFFECTS OF COPPER OXIDE NANOPARTICLES ON GABAERGIC SIGNALING IN PRIMARY CELL CULTURES OF TRIGEMINAL GANGLION NEURONS AND GLIA

Mikayla Scharnhorst, Daniela Silva, Donovan Aardema Faigh, Sophia Antonopoulos. Biology Department/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

Heavy metal nanoparticles used in a variety of industries can leach from devices and contaminate the surrounding environment, posing a threat to human health. Divalent copper oxide nanoparticles (CuO NPs) are toxic to diverse cell types by causing DNA damage and oxidative stress. The inhibitory neurotransmitter gamma-aminobutyric acid (GABA) via activation of GABAA and GABAB receptors protects cells of the nervous system from damage. Cryopreserved trigeminal ganglia from neonatal Sprague-Dawley rats were used to establish primary neuron-glia cultures. Following overnight incubation, greater CuO NPs toxicity was observed in glial cells compared to neurons. To better understand CuO NP-induced toxicity, expression of receptor proteins in the GABA pathway were investigated by immunocytochemistry. The expression of the GABAB2 receptor subunit remained unchanged with all concentrations of CuO NPs in glial cells but was decreased in neurons at the highest concentration of CuO NPs. The GABAB1 receptor subunit and GABAA receptor expression were decreased in both neurons and glia at the highest concentration of CuO NPs. Findings from our study provide evidence that the toxicity seen with CuO NPs in the trigeminal ganglion glia could be due to dysregulation of GABAergic signaling which is reported to inhibit inflammation and minimize toxicity.

#30 – METHOD FOR CRYOPRESERVATION OF SPINAL CORD TISSUE FOR ESTABLISHING PRIMARY CULTURES OF NEURONS AND GLIA

Daniela Silva Torres, Sophia Antonopoulos. Biology Department/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

Primary cultures are used to elucidate cellular and molecular mechanisms involved in disease pathology and modulation by pharmaceuticals and nutraceuticals, and to identify novel therapeutic targets. However, preparation of primary cultures from rodent embryos is labor-intensive, and it can be difficult to produce high-quality consistent cultures. To overcome these issues, our lab has developed a simplified cryopreservation method for establishing primary cultures of upper spinal cord neurons and glia from Sprague-Dawley neonates, using a 90:10 (v/v) fetal bovine serum/dimethyl sulfoxide cell freezing medium. The Live/Dead Cell Imaging assay was used to determine cell viability of the cultures and immunocytochemistry was used to characterize basal expression of proteins. Cryopreserved spinal cord cells stored >1 year in liquid nitrogen retained high cell viability and exhibited similar neuronal (NeuN and β-tubulin) and glial cell (vimentin) morphology to fresh cultures. Neuronal and glial proteins implicated in inflammation and pain signaling (CGRP, GFAP, Iba1, GAD 65/67, GABA receptors) were expressed in cell types in agreement with published studies. This method, which is simple, does not require special reagents or equipment, saves time and money, increases flexibility in study design, and produces consistent cultures, can be used to study cellular changes to inflammatory and anti-inflammatory agents.

#31 – FLUORESCENCE CHANGE OF THERMOSTABLE PROTEIN CPT TO CTPT AFTER RANDOM MUTAGENESIS

Austin D. Brown. Chemistry and Biochemistry. Faculty Advisor: Dr. DeVore

Thermostable fluorescent cyan protein, CTP, was derived from the Thermal Green Protein (TGP) that was synthesized at the Los Alamos National Laboratory in an attempt to change its fluorescent properties from green to cyan fluorescence. In the process, we were able to change its fluorescence by incorporation of a tryptophan instead of a tyrosine in the chromophore, but this protein CTP had a decrease in brightness (quantum yield). A new mutation, I199T was incorporated to improve the quantum yield and denoted as CTP-T. Protein crystals were grown of CTP-T and a data set was collected to 2.25 Å. This structure suggested sites for further mutations. We achieved this by performing random mutagenesis on residues 143-146 of CTP-T. In the first attempt, a single white colony instead of the expected bright yellow colony, was identified as CTP-T 143-146 White containing four mutations in residue 143-146 (W143Y,E144F, P145F, S146L). We then used spectrometry and fluorometry to test the absorption and fluorescence of the newly mutated protein and discovered that there was a clear change of fluoresce color between the CTP-T and CTP-T 143-146 White protein to blue fluorescence. The functionality of the CTP-T 143-146 White protein was tested for pH, chemical, and thermal stability. We are attempting to obtain protein crystals for X-ray diffraction experiments.

#32 - THERMOSTABILITY AND CRYSTAL GROWTH OF THE CYAN FLUORESCENT PROTEIN, JG6

Samantha Ball. Chemistry and Biochemistry. Faculty Advisor: Natasha Devore

The goal of this experiment was to develop a thermostable version of the cyan fluorescent protein based on the thermal green protein. JG6, the version we are working with, was identified from a random mutagenesis experiment colony screen due to a brighter yellow color compared to the previous versions; it contains a total of six mutations when compared to thermal green protein (Y67W W143L E144C P145F S146F I199T). Experiments were created to analyze the expression and stability of the cyan fluorescent protein. The protein was expressed in E. coli and purified using nickel affinity chromatography. SDS-PAGE was run to determine the purity of the protein's purification. A set of fluorescent protein crystallization screens were created with a spectrum of pH environments. The SDS-PAGE results showed the protein's purity was sufficient. The cyan protein was found to be mildly chemically stable. The protein was found to be most stable under neutral conditions and with moderate thermostability in relation to its stability at higher temperatures. Further analysis of the protein, JG6, will be completed pending the growth of crystals on the crystallization screen.

#33 - CHARACTERIZING CYAN THERMOSTABLE FLUORESCENT PROTEINS ENGINEERED BASED ON THERMAL GREEN PROTEIN (TGP)

Trey Norman, Anastasia Jones, Andrew Yates. Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore

The DeVore lab is working to engineer a thermostable cyan protein based on an extreme green thermostable fluorescent protein, TGP. The first version of a cyan thermostable protein was not very fluorescent and lacked much of the stability observed in TGP. We have characterized the second-generation mutant proteins CTP-S (Y67W I199S) and CTP-T (Y67W I199T) for chemical (guanidine hydrochloride), pH, and thermal stability. In addition, we purified a third-generation protein, CTP-T JG2, which contains six mutations Y67W W143L E144I P145D S146A I199T using nickel affinity and ion exchange chromatography. After purification, CTP-T JG2 was assayed for chemical, pH, and thermal stability. The CTP-T JG2 protein has improved chemical, pH, and thermostability compared to CTP-S and CTP-T.

#34 - PROTEIN CHARACTERIZATION AND CRYSTAL STRUCTURE OF YELLOW THERMOSTABLE PROTEIN (YTP) Q66E E148D

Victoria Ogbeifu, Caitlin M. Padgett & Natasha DeVore. Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore

The goal of this project is to examine the stability of the thermostable fluorescent protein YTP-E-D. The protein is a mutated version of the yellow thermostable protein (YTP). The mutation was accomplished by altering a histidine that is located near the chromophore at the 197 location into a Tyrosine (H197Y). Site-directed mutagenesis was then utilized to conduct the following mutations Q66E and E148D. With a significantly lower quantum yield than its counterpart YTP-E, this study focused on evaluating the stability of the YTP-E-D by performing several assays. The pH assay revealed a curve that showed about 50% fluorescence at pH 7, with a maximum fluorescence at pH 10. The chemical stability of YTP-E-D had a Cm of 1.9 M Guanidium Hydrochloride, which was not as stable as YTP-E. Likewise, the thermal stability of YTP-E-D is not as good as that of YTP-E or YTP, but better than the corresponding green TGP and TGP-E. YTP-E-D did express at a higher level than YTP and YTP-E and had much less of a lower molecular weight contaminant during purification. Protein crystals of YTP-E-D were superior to those obtained for YTP and YTP-E and led to a protein crystal structure solved to 2.6 Å resolution. This structure gives insight into how to further improve yellow thermostable protein

#35 - GREEN ALTERNATIVES IN SULFA DRUG SYNTHESIS

Lisa Mitchell and Collin Mourot. Chemistry. OTC Faculty Advisor: Patrick Casey.

The production of sulfa drugs traditionally utilizes harsh chemicals that take a significant amount of time to produce. The overall goal of this research is to produce these drugs in a more environmentally friendly method while trying to shorten the process. Our research was focused on finding a stable form of sulfonyl chloride in the production of sulfa drugs. The *p*-acetamidobenzenesulfonyl chloride that we worked with originally was not shelf stable. The weekly time restriction of the course proved difficult with an unstable intermediate. Sulfonyl chloride was converted to a sodium sulfinate salt through reaction with sodium sulfite. From there, we used a variety of amines with the sulfinate salt to find the optimal conditions to produce the final sulfa drug. We successfully created a final product, verified with melting point. The yields were low but measurable. The restraint on time that we experienced, only meeting once a week, made further optimization of procedure difficult and further investigation is needed.

#36 - AMERICAN ELDERBERRY FRUIT QUALITY IS NOT AFFECTED BY WEED MANAGEMENT METHOD

Avery Roweton and Gypsy Pitts, Ozarks Technical Community College, Department of Physical Science. OTC Faculty Advisor: Diann Thomas
Matthew Huchteman, University of Missouri, Division of Plant Science and Technology. Faculty Advisor: Andrew Thomas

This study aimed to determine the effects various systems of weed management on the chemistry within American elderberry (*Sambucus nigra* subsp. *canadensis*) fruit. Each sample was tested for five qualities: soluble solids concentration (SSC), pH, titratable acidity (TA), polyphenols, and anthocyanins. To prevent bias, the samples were randomized for members on the lab team. While we found statistical differences in fruit characteristics among cultivars and growing locations, differences among weed management systems were not detected. Overall fruit characteristic means were SSC 9.50%, pH 4.42, TA 0.50 g/100 mL citric acid equivalents, polyphenols 341 mg/100 g gallic acid equivalents, and anthocyanins 84 cyanidin-3-glucoside equivalents. While weed management is certainly critical to successful elderberry production, our study indicates that factors other than weed management techniques are more influential in determining fruit quality. This study will continue for the next two years to determine if there are other influences on the chemistry of the fruit.

#37 – DEVELOPMENT OF GREEN ALTERNATIVE METHODS IN THE PRODUCTION OF SULFA DRUGS

Rain Wolfe and Steven Baker, Chemistry. OTC Faculty Advisor: Patrick Casey

This study aimed to research different methods of synthesizing sulfa drugs using green methods. First, we experimented with several methods of synthesizing 4-amino-n-p-tolylbenzenesulfonamide and 4-(morpholino sulfonyl) aniline. During our research, we synthesized these two sulfa drugs using the traditional methods. Then we compared using greener methods without some of the harsh solvents and chemicals used. We mainly used melting point and IR to identify our compounds. We used research from our previous semester to green the procedure to synthesize sulfamethoxazole, a commonly prescribed antibiotic. This process was shown to be most effective when using the amine as its own solvent. Finally, we expanded upon methods from previous research and tested those methods on multiple different sulfa drugs under a variety of experimental conditions. Utilizing these experimental methods, we aimed to develop ideal conditions for producing our desired sulfa drugs.

#38 - SYNTHESIS OF BIODEGRADABLE DENDRITIC POLYMERS FOR THE TARGETED DELIVERY AND TREATMENT OF LUNG CANCERS

Trishna Timalsena, Neelima Koti and Santimukul Santra. Chemistry and Biochemistry. Faculty Advisor : Santimukul Santra.

Clinical applications of many hydrophobic drugs used in chemotherapy remain largely limited due to their poor water solubility, leading to poor bioavailability. Engineered nanocarriers provide a solution by improving drug solubility, stability, and controlled drug release, consequently enhancing drug efficacy. In this study, we developed a novel hyperbranched polymer for the precise delivery of hydrophobic drugs. The polymer was synthesized using a malonic acid-based A_2B monomer and 1,6-hexanediol via co-condensation under melt conditions. Analyses through experimental techniques confirmed its dendritic structure, thermal stability, and higher molecular weight, making it suitable for drug delivery systems. To demonstrate its ability to deliver drugs, lung cancer A549 cells were selected as a model cancer cell line. Utilizing the one-pot solvent method we co-encapsulated hydrophobic drugs BQU57 and doxorubicin within the nanocarrier and the surface was conjugated with folic acid using EDC/NHS chemistry to target folate receptors expressed on A549 cells. The results were evaluated through various cell-based in vitro experiments including cytotoxicity, cell internalization, ROS, apoptosis, migration, and comet assays. Overall, findings from the study indicate that the formulated nanoparticle is a promising carrier for hydrophobic anticancer drugs with higher biocompatibility and therapeutic efficacy, showing immense potential for drug delivery applications.

#39 - FACILE SYNTHESIS OF POLYMER STABILIZED REUSABLE GOLD NANOCATALYSTS FOR EFFICIENT AND SUSTAINABLE HYDROGENATION REACTIONS

Egor Glushkov, Kajal Kajal and Santimukul Santra. Chemistry and Biochemistry. Faculty Advisor: Santimukul Santra

Polymer-coated metallic nanocatalysts can be utilized in a wide range of chemical processes due to their sustainable catalytic activity and great recyclability. In this study, a facile synthesis of a hydrophilic Hyperbranched PolyHydroxyl (HBPH) polymer using diethanolamine as starting monomer material is reported. The polymer was observed to have a high molecular weight, making it suitable for multiple-use applications due to its ease of recovery from the solution. HBPH-stabilized gold nanoparticles (GNPs) were formulated using a one-step conventional Turkevich method and characterized using various spectroscopic methods. Catalytic performance of formulated HBPH-stabilized GNPs was investigated using a model reduction reaction of p-nitrophenol with sodium borohydride. UV−Vis studies were performed to monitor the reaction rate. The reaction parameters were optimized via time-dependent and concentration-dependent kinetics studies. Obtained HBPH-stabilized gold nanocatalysts exhibited high degrees of recovery and recyclability. This ease of repeated use along with the use of hydrophilic aliphatic fragments in the formulation of the HBPH polymer makes the resulting HBPH-GNPs catalysts biocompatible and environmentally friendly.

#40 – SYNTHESIS OF BIOCOMPATIBLE POLYESTER POLYMER FOR DRUG DELIVERY APPLICATIONS

Taemin Park, Wadha Alqahtani, Neelima Koti and Santimukul Santra. Chemistry and Biochemistry. Faculty Advisor: Santimukul Santra

In this study, we synthesized a linear polyester polymer using bio-based molecules including sorbitol and glutaric acid. We used a greener approach for the polymer synthesis by replacing toxic catalyst with Novozyme-435 enzyme. The resulting polymer was expected to have amphiphilic properties that would be suitable for diverse drug delivery applications. The resulting polymer was purified using the solvent precipitation method, where the polymer in DMSO solvent was precipitated in water and centrifuged. Using the one-step solvent diffusion method the chemotherapeutic drug doxorubicin was encapsulated in the polymer cavities, and click chemistry was followed to conjugate folic acid on the surface. The cytotoxicity of the polymer-based nanomedicine was determined using MTT assay, ROS detection studies, Comet assay, and Migration assay, and the internalization was measured by fluorescence microscopy. Results indicated that our bio-based linear polyester polymer, synthesized with greener approach, was successfully targeted, and delivered chemotherapeutic drugs for the treatment of prostate cancer. This study shows the promising potential of a sorbitol-based, biodegradable novel polymer as a drug delivery system for biomedical applications and the key results will be highlighted in this presentation.

#41 – KINETIC MODULATION OF A-SYNUCLEIN FIBRILLATION AND TOXICITY BY 4-PHENYLBUTYRIC ACID

Sathvika Balerao, Kristos Baffour, Neelima Koti, Rishi Patel, Santimukul Santra, and Tuhina Banerjee. Chemistry and Biochemistry. Faculty Advisor: Tuhina Banerjee

Alpha-synuclein (α-syn) protein misfolding and aggregation into toxic amyloids are the main causes of Parkinson's disease (PD) and other neurodegenerative diseases. While most therapies for PD focus on alleviating symptoms, inhibiting the formation of toxic α-syn amyloids is a promising approach to reduce PD pathology. 4-Phenylbutyrate (PBA) is a derivative of butyrate that is approved for treating urea cycle disorders and is being researched as a potential treatment for a range of neurodegenerative diseases. This study investigated the potential of PBA in reducing α-syn aggregation and its implications for PD pathology. The study found that PBA treatment alters the pattern of α-syn aggregation, as evidenced by reduced formation of toxic oligomeric species and increased susceptibility to proteolytic cleavage. PBA interacts with the hydrophobic contacts of α-syn oligomers and significantly reduces α-syn-amyloid induced toxicity, suggesting that oligomerization is essential for α-syn to exert its neurotoxic effect. Current studies evidenced the PBA interaction with α-syn oligomers and explains its ability to mitigate α-syn-induced cytotoxicity. These findings provide compelling evidence for the neuroprotective potential of PBA in targeting protein misfolding and aggregation in PD and suggest an avenue for disease-modifying interventions in neurodegenerative disorders.

#42 - MEMBRANE FUSION INTERACTIONS OF ENVELOPED VIRUSES USING MAGNETICALLY-LABELED LIPOSOMES

Santimukul Santra, Clayton Frazier, Paris Yates, Elizabeth Bowie, Megan Liermann, David Johnson and Tuhina Banerjee. Chemistry and Biochemistry, Faculty Advisor: Tuhina Banerjee

The impacts of highly pathogenic enveloped viruses, such as SARS-CoV-2, have turned scientific inquiry toward the fusion mechanisms responsible for viral pathogenesis, and to seeking cost-effective, fast-acting, and adaptable strategies to mitigate future outbreaks. Although current methodologies have illuminated the fusion mechanisms employed by SARS-CoV-2, they possess key limitations preventing their widespread utility in quickly adapting to outbreaks of emergent enveloped viruses, such as high financial or instrumental costs, technical operational proficiency, cytotoxicity, or viral specificity. This paper measures changes in spin-spin T2 relaxation times using a bench-top NMR instrument as a bioanalytical approach to quickly quantify fusion interactions between the SARS-CoV-2 spike protein and liposome-iron oxide nanosensors (LIONs). Specifically, this study modifies the LIONs platform by appending protein receptors to the LIONs, thereby creating R-LIONs, such as LIONs-ACE2, which mimic the ACE2 host cell receptor targeted by SARS-CoV-2, along with other receptors suspected to be involved in viral fusion. Environmental factors impacting fusion, such as pH, temperature, calcium, and cholesterol, were likewise investigated. The findings suggest the utility of the R-LIONs platform in providing a customizable, fast-acting, inexpensive, and accessible mechanism for examining the fusion process of SARS-CoV-2 and other emergent enveloped viruses.

#43 - PARRIS ISLAND COS ROMAINE LETTUCE (*LACTUCA SATIVA*) IN MARS SIMULANT SOIL TREATED WITH SULFUR-BASED NANOFERTILIZERS

Riley Pope, Mary Fakunle, Iqra Shakoor, Preston Clubb, Cyren Rico Chemistry and Biochemistry. Faculty Advisor: Cyren Rico

This study analyzed the effects of sulfur-based nanofertilizer on the growth of Parris Island Cos romaine lettuce (*Lactuca sativa*) grown in Mars simulant soil. The lettuce was grown for fifty days in one of two soil compositions 100% Earth soil or 50% Earth soil and 50% Mars simulant soil (mixed soil). Among the two different soil compositions, there were three different spray treatments: 5 mL of 20 µg/mL sulfur nanoparticles, 5 mL of 50 µg/mL molybdenum sulfide nanoparticles, or 5 mL of deionized water as a control. The height and biomass of each treatment were measured and a Cary 60 UV-Vis Spectrometer was used to conduct are chlorophyll analysis. Results show that neither sulfur-based nanofertilizer boosted the growth of the lettuce plants grown in Mars simulant soil.

#44 – BIOGENIC PERSISTENT FREE RADICALS IN PLANT LEAVES: LIGHT-INDUCED FORMATION AND SYSTEMIC SIGNALING

Riley Pope, FNU Khushboo, Preston Clubb, Jacob Churchman, Eric P. Vejerano, Cyren M. Rico. Chemistry and Biochemistry. Faculty Advisor: Cyren Rico

Stable organic free radicals, characterized by an unpaired electron, exhibit unique chemical properties. Our research identified substantial quantities of biogenic persistent free radicals (BPFRs) in plant leaves, a novel finding suggesting these radicals' roles are distinct from those derived from combustion processes. We discovered that BPFRs are inherently present in unaltered leaves and their levels are modulated by light, pointing to a relationship with photosynthesis. We systematically exposed various plants, such as lettuce, lemon basil, spinach, and scallion, to both natural and artificial sunlight under controlled conditions. Subsequent analysis using an X-band Bruker EMXplus electron spin resonance spectrometer indicated an increase in BPFR concentration with light exposure, highlighting the crucial role of light in their modulation. Select lemon basil plants were exposed to artificial sunlight. A notable observation was that BPFR levels reached a plateau after a certain exposure period, suggesting a saturation point in their formation. Also, leaves not directly subjected to light also demonstrated elevated BPFR levels, implying a systemic response within the plant. Plants subjected to thermal shock at 35 ^{o}C also exhibited an increase in BPFR formation compared to the control. Our results reveal that BPFRs may have a more complex function in plant defense and resilience. Their persistence under various environmental stresses raises important questions about their important biological functions in plants. Our findings open new research paths regarding the role of stable free radicals in plant biology. They underscore the need to further explore the mechanisms of BPFR formation and their significance in plant physiology, especially concerning how plants manage light and thermal stress.

#45 – TOWARDS ELECTROCHEMICAL SENSORS FABRICATED BY AN INKJET-PRINTER

Joe Truong. Chemistry and Biochemistry. Faculty Advisor: Dr. Adam Wanekaya

This project presents the development of a miniaturized, inkjet-printed electrochemical system, designed for field applications. This work aims to scale down traditional electrochemical setup to interface directly with smartphones. Inkjet-printed electrodes were successfully fabricated. The design allows the integrated reference, counter, and working electrodes to operate effectively with just a single drop of solution, making it ideal for micro-volume analyses in field applications. Glucose detection using copper (II) oxide (CuO) in basic solution was employed as a baseline for proof of concept. Characterization of the synthesized CuO nanoparticles has been performed using various spectroscopic methods. Calibration curves for glucose detection as well as cyclic voltammetry study of K3[Fe(CN)6] on the conventional setup were performed. Ongoing work aims to replicate these findings using the mobile phone-based potentiostat.

#46 – 2D ^{1}H-NMR STUDIES OF A SINGLE MODIFIED LOCKED NUCLEIC ACID IN A SEQUENCE OF AN OTHERWISE UNMODIFIED DNA SEQUENCE

James Wilson. Chemistry and Biochemistry. Faculty Advisor: Dr. Gary Meints.

In this study, ^{1}H-NOESY 2D NMR was utilized to reexamine the palindromic Deoxyribose nucleic acid (DNA) sequence [5'-C-G-C-A-A-A-T-T-T-G-C-G-3'], referred to as A3T3, to then perform a NOESY 2D experiment on an A3T3 sequence with a locked nucleic acid on the third cytosine base (LC3) and compare the chemical shifts of the two structures. Specifically, in this experiment, a 10℃ run of the Locked nucleic acids was compared to a 25℃ run. Locked nucleic acids (LNA) consist of a methylene link bridging the 2'-O and the 4'-C, this decreases the number of expected ^{1}H protons at the 4'-C by one but adds two ^{1}H protons on the C atom of the methylene group, both of which are available to engage in cross relaxation with other ^{1}H protons in the molecule, leading to a theoretical increase in peaks and fundamentally altering the helical geometry and the assignments of subsequent 1' to base assignments. The LC3 A3T3 DNA sequence, ran at 10℃ was found to have chemical shifts that were distinct from the A3T3 unmodified sequence, with additional differentiation from the LC3 A3T3 DNA sequence at 25℃. This was accomplished using a NOESY walk or sequential chemical shift assignments. In future studies the heteronuclear single quantum spectrum should be taken and the 31P spectrum should be taken to better understand the mechanism of DNA replication.

#47 - UAV ATTACKS DETECTION USING DEEP LEARNING

Dorian Morrissey. Computer Science. Faculty advisor: Dr. Belkhouche

Unmanned Aerial Vehicles (UAVs) are widely used in many industries due to their versatility, low cost, and autonomy. With that newfound prevalence comes attention from hackers, especially as more industries become more reliant on drones. Exploits and the frameworks to deploy them are developed and released. This naturally prompts cybersecurity experts and practitioners to develop and implement advanced methods to prevent adversaries from attacking UAVs. In this project, we explore one solution to secure UAVs through a Convolutional Neural Network (CNN) to analyze sequential telemetry data generated by simulated drone routines. Specifically, the dataset used in this project contains six different drone types with three types of traffic for each. These three include benign traffic, traffic experiencing a Denial of Service (DoS) attack, and traffic experiencing a GPS spoofing attack. The established CNN model achieved 97.4% accuracy in detecting these types of malicious traffic across all six UAVs.

#48 - INCREASING EXPLAINABILITY OF DIMENSION REDUCTION METHODS FOR MACHINE LEARNING OUTCOMES

Tony Enrique Astuhuaman Davila. Computer Science. Faculty Advisor: Dr. Tayo Obafemi-Ajayi

Dimension reduction techniques visualize outcomes of machine learning models on complex data. The objective is to transform high-dimensionality input data to a lower-dimensional space (usually 2D or 3D) for better human comprehension. These techniques have parameters that strongly affect the visualization. Though visual inspection of projected dimensions could be appealing, interpretability of classes in relation to input features usually lacks. This work presents an automated framework for transforming dimensional reduction plots into a viable explanation space by embedding significant features onto the projected space. Our approach conducts a grid search of the parameter space of reduction methods to determine the optimal parameters based on the silhouette score. It applies an ensemble feature importance score to select the optimal subset of input features to overlay with group centroids on plots. The aim is to increase interpretability and utility of these plots in explaining the structure of groups represented by model outcomes. We demonstrate our approach by applying it to datasets from phenotypes of neurogenetic diseases. The framework is accessible on our GitHub page, providing a resource for researchers to explore and implement the methodology

#49 - PADDLE OBSOLESCENT NOVELTY KNOCK-OFF (PONK)

Nathaniel Van Devender, Michael Hardesty, Aaron Frater, Gabriel Fedynich. Cooperative Engineering. Faculty Advisor: Dr. Rohit Dua.

The Paddle Obsolescent Novelty Knock-Off serves to pay homage to the grandfather of all video games: PONG. The system features a faithful recreation of the game's analog circuitry, using vintage components as available. To extend the appeal of the project, the television display has been replaced by a mechanical cartesian coordinate display utilizing the Core-XY principle that tracks the analog signals from the PONG circuitry and moves a ping-pong ball in a display field. Furthermore, the rotary knob game controllers have been replaced with a touch-free hand sensor array that allow users to wave their hands in front of the display to control the PONG "paddles" to strike the ping-pong ball and win the game. The PONK system acts as a fun and inventive interactive art piece that draws the attention of passersby and teaches them about vintage analog circuitry and mechanical systems.

#50- INTEGRATING INTERNET OF THINGS (IoT) FOR AUTOMATED SMOKER CONTROL

Trenton Cathcart, Parker Widmeyer, Gabriel Boicu. Electrical Engineering. Faculty Advisor: Rohit Dua

This project aims to convert a simple, generic smoker to an automated smoker with Internet of Things (IoT) connectivity. Devices such as servo motors, fans, a microcontroller, and a temperature sensor were added to the smoker, which will all be controlled automatically in response to a set temperature by the operator. The operator can set this temperature on a mounted touch-screen, as well as control the individual devices for troubleshooting purposes and control all features from a user's remote internet accessible device. To determine the components that were added, a requirements matrix was created that established goals that, if met, would be deemed a successful conversion to an automated smoker. These requirements will be the tests that the smoker must pass, like maintaining a set temperature within ±20°F.

#51 - DIRECT FPGA CONTROL IN LED CUBE DESIGN: A PATHWAY TO EFFICIENT AND INTERACTIVE DISPLAYS

Alex Lukomskiy, Thomas Ramsey, Electrical Engineering, Faculty Advisor: Dr. Dua

This project centers on the development and operation of an 8x8x8 LED cube, which is directly controlled by an Altera DE2 Cyclone II FPGA board, programmed using Verilog HDL. The design capitalizes on the full GPIO capacity of the FPGA, eliminating the need for additional controlling hardware, thereby enhancing system efficiency. This direct control mechanism facilitates precise two-coordinate LED addressing via distinct layer and column management, simplifying the programming model while optimizing electrical efficiency. A micro and macro framing strategy was utilized, which activates only one LED at a time to ensure efficient pattern tracing and minimal power consumption. The extensive parallel processing capability of the FPGA was harnessed to manage these tasks effectively, illustrating the board's capability to execute complex control tasks seamlessly and at a very high frequency. Moreover, the cube features a fully implemented sound-reactive component, enabling dynamic pattern changes in response to ambient sounds. This functionality showcases the FPGA's versatility in integrating and managing additional interactive features.

#52 - AUTOMATED LOAD FRAME

Jack Stone, Braxton Hall, Nicholas Winn, Nicholas Stogsdill. Electrical and Civil Engineering, Faculty Advisors: Dr. Matthew Pierson and Dr. Rohit Dua

This project aims to automate a hydraulic load frame for the purposes of testing concrete strength. The load frame is in use at the MST Cooperative Engineering Program and needed to be designed around in order to add automation components. Originally the load frame was only able to conduct a compression test, however with automation new tests are/will be available. We added a step motor, sensors, a counter, a programmable logic circuit (with power supply and I/O modules), and various other small components to measure the moving parts of the system. Automating the system allows for much more accurate data collection than relying on human response times, this leads to more accurate results and the addition of the Double Punch test. The position of the load is monitored and when a sudden move is detected that is determined to be a break in the concrete. When the break is detected the automated system will perform calculations and return results based on the desired test

#53- DECONSTRUCTED 555 TIMER AND APPLICATION CIRCUITS FOR INTERACTIVE EDUCATIONAL EXPERIENCES

Benjamin Cuebas, Justin Fausto, Preston Carroll. Electrical and Computer Engineering. Faculty Advisor: Rohit Dua

The Deconstructed 555 Timer and Application Circuits for Interactive Educational Experience offers interactional implementation of three fully discrete 555 Timer example circuits. The research project goal was to gain knowledge of the 555 Timer by deconstructing the device down to the component level. Three independent example application circuits, which showcase the application versatility of the 555 Timer in different modes, include Monostable, Astable, and Bistable circuits. Each mode has a hardware interface that can be used to adjust the operation of the 555 Timer allowing for a full interactive experience. The user can observe the differences in the internal working of the 555 Timer for the implemented applications. The built product is an educational and engaging interactive board which uses LEDs and OLED displays to describe the internal functionality of a 555 Timer and its application versatility. The undergraduate research concentrated on building skills in circuit design and product development.

#54- SLAPIT (SIGNAL LANGUAGE AND PHYSICS IT)

Alexis Villela and Jamie Madison. Electrical Engineering, Faculty Advisor: Rohit Dua.

The goal of this project is to create an interactive learning device that would facility binary code learning to the users through interactive engagement with Raspberry Pi and various sensors, including LDRs or push buttons, LEDs, and LCD displays. Levering diverse learning types, including visual, auditory, reading and writing, learners will engage with binary concepts through hands-on experimentation and real-time feedback. The project will be configured to use only 8-Bit input. We will implement voice command controls as well as audio output to keep it user-friendly and create a personalized experience. Some of the programs will include binary arithmetic calculation, Hex and ASCII binary translation, file and directory creation with binary. It was our hope that our project might encourage youth to get involved in STEM programs and become interested on how computing systems and machine code work using binary. Overall, this project represents a significant step in improving the interactive learning experience of digital electronics and computing systems.

#55 – THE EFFECTS OF TEMPERATURE AND PRESSURE ON THE ELECTROCHEMICAL PRODUCTION OF FORMIC ACID

Gavin Reese, Dr. Daniel Moreno Cooperative Engineering. Faculty Advisor: Daniel Moreno

To mitigate atmospheric CO_2 emissions and provide sustainable fuel sources, CO_2 can be converted into various fuel products. One such product is formic acid, which has useful applications in agriculture and hydrogen storage. The effects of temperature or pressure are of recent interest because values slightly above ambient, but not substantially large, are used in performing a reduction reaction to improve CO_2 conversion to formic acid. In this work, an H-cell is used for the reaction with Tin coated Copper electrodes to prioritize formic acid. To test temperature, the H-cell's temperature was increased where then formic acid samples were taken and analyzed. As for pressure, the setup is being worked on to seal the H-Cell to hold pressure up to 5 bar. Both effects are analyzed using Columbic (CE) and Energy (EE) Efficiency calculations. By varying the pressure and cell voltage, CE was maximized at values of 73.6% at voltage of 1.25 vs. Ag/AgCl reference electrode, and EE was maximized at values of 92.8% at voltage of 1.5 vs. Ag/AgCl and temperature of 50 °C. In the future, this cell will be tested with various pressures and samples will be collected and analyzed to gather data for future efficiency calculations.

#56 - EXPLICIT REPEATED DOT PRODUCT TREE CONSTRUCTIONS

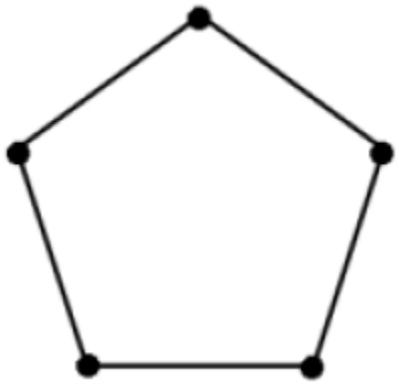
Christopher Housholder, Mathematics. Faculty Advisor Steven Senger

We produce a family of explicit constructions of large finite point sets. These sets exhibit extremal behavior with respect to dot product trees.

#57 – THE PRODUCT OF THE CHROMATIC NUMBER AND INDEPENDENCE NUMBER OF A GRAPH

Rachel Lee, Mathematics. Faculty advisor: Dr. Les Reid

Given a graph G, its chromatic number $\chi(G)$ is the smallest number of colors needed to color its vertices so that no vertices connected by an edge have the same color. Its independence number $\alpha(G)$ is the largest number of vertices such that no two vertices are connected by an edge. For example, the graph shown below has $\chi(G) = 3$ *and* $\alpha(G) = 2$.



It is well known that $\chi(G)\alpha(G) \geq n$, where n is the number of vertices of G. Recently, Hefty and Johnson established an upper bound $f(n)$ for $\chi(G)\alpha(G)$. [1,2.] In this talk, we will discuss this upper bound and determine which values in the range $[n, f(n)]$ can occur.

#58 – THREE-DISTANCE SETS OF FIVE POINTS IN THE PLANE

Andrew Meek. Mathematics. Faculty Advisor: Dr. Les Reid

This project aims to investigate the possible configurations of three-distance sets of five points in the plane. A well-known version of this problem asks for the different configurations of four sets of points in the plane such that the set of six distances between them has two elements. For example, a unit square has four sides of length 1 and two diagonals of length $\sqrt{2}$. This is an example of a two-distance set of four points in the plane. In this case, there are six configurations. We will describe our methods and give some preliminary results.

#59 – DATA ANALYSIS AND MODE IDENTIFICATION OF VARIABLE SUBDWARF B STARS IN SECTORS 61-69 OF TESS DATA

Jacob Henderson, ARDASTELLA research team. Physics, Astronomy & Materials Science. Faculty advisor: Dr. Andrzej Baran

In the Fall of 2024, we did a survey of sectors 61-69 of TESS space telescope data in order to identify variable stars for further study. From these data, 10 identified subdwarf B pulsators were selected to be analyzed. We present the results of our mode identification processes on these stars. Between the stars, a total of 191 peaks were detected and prewhitened in the g-mode region of the frequency spectra. All peaks were examined within the period domain. Period spacing searches yielded the means to constrain many of the peaks to either the l = 1 or l = 2 period spacing sequences described in the literature. Results from TIC 40050637 indicate an average period spacing of 235.336 ± 0.152 s for its l = 1 sequence. Results from TIC 68873560 indicate an average period spacing of 267.880 ± 3.524 s for its l = 1 sequence. Additional tools, such as the KS test and Echelle diagrams, are used to provide further justification for our conclusions. These results help to improve existing models of subdwarf B stars.

#60 – A PHOTOMETRIC SURVEY OF VARIABLE STARS IN THE OPEN CLUSTER NGC 188

Samuel Cope. Physics, Astronomy & Materials Science. Faculty Advisor: Andrzej Baran.

NGC 188 has been researched extensively, including surveys finding short term pulsators. Most of the past literature did not have surveys with a longer temporal baseline, leaving room for new contributions to the field of astronomy. A 6-month photometric survey of the old open star cluster NGC 188 is discussed. Using the CDK20 Planewave telescope at Missouri State University's Baker Observatory, photometric data of a 12' by 12' field of NGC 188 is being collected and analyzed. About 40 nights of data have been collected so far. This study will ideally result in the discovery of new pulsators and other variable stars. Additionally, previously discovered variable stars will be analyzed with a longer baseline, revealing the long-term behavior these stars exhibit. GAIA data will be employed to discuss the evolutionary status of these stars, with the goal to find an independent age and distance to the cluster.

#61 – ORBIT PERTURBATIONS TO HABITABLE ZONE PLANETS FROM A MASSIVE PLANET AT THE PRIMORDIAL WATER ICE SNOWLINE AROUND M STARS AND G STARS

Bishwash Devkota, Sarah J. Morrison, Samuel Cope. Physics, Astronomy & Materials Science. Faculty Advisor: Sarah Morrison

The search for extraterrestrial life is dependent on finding planets with conditions crucial to its development. For this study, the influence of massive planets located near the primordial water ice snowline on the orbital stability and habitability of Earth-mass planets is examined. In particular, these Earth-mass planets are in the habitable zone of two types of stars, G and M. Using dynamical simulations, various scenarios such as including Earth-mass planets at different locations within the habitable zone, different shapes of the orbit and varying masses for the snowline giant were explored. Our analysis showed the magnitude and timescales of orbital variations experienced by the habitable zone planet in each simulated scenario. The results showed that the habitable zone planets around the M stars are more significantly perturbed by nearby massive planets compared to those around the G stars. These findings imply that these perturbations can affect the amount of stellar radiation received by the Earth-mass planet which can affect the climate and the ability to support life.

#62 – OUTCOMES OF SUPER-EARTH FORMATION IN THE PRESENCE OF A JUPITER-LIKE PLANET

Simarpreet K. Girn, Sarah J. Morrison, Caroline Witt, Mateo E. Guerra Toro. Physics, Astronomy & Materials Science, Faculty Advisor: Sarah Morrison

Super-Earths are found to be the most common planets closest to their host stars. They are planets ranging slightly larger than Earth to the size of Neptune. However, in our solar system, we do not have any super-Earths, one of the reasons could be because of Jupiter. For this project, we analyzed how a big outer planet like Jupiter can affect the formation of inner planets. We performed ninety-two N-body simulations replicating planetary formation in a protoplanetary disk where we placed a Jupiter-sized planet 5 AU from its host star. First, we looked at outcomes for when the protoplanetary disk is present, and then when the disk is gone. We then compared the results from these simulations to ones without a large planet. At lower densities, we saw more planets formed in both cases. The average mass and eccentricity of the inner planets were higher in systems that did not contain an outer Jupiter. Additionally, there was a tendency for the average number of planets produced to be higher in simulations with an outer Jupiter. We will discuss which parts of these simulations we can see using exoplanet surveys that look for planets passing in front of their stars.

#63 - MODELING GOLF MATERIALS USING MTP ARTIFICIAL INTELLIGENCE

Helena Bel Arbunies. Physics, Astronomy & Materials Science. Faculty Advisor: Dr. Ridwan Sakidja

This project aims to investigate the material properties of stainless steel and graphite composite materials used in golf club shafts by using AI simulations and comparing the results to previous empirical experiments to determine the accuracy of AI predictive models. This study incorporated the utilization of Moment Tensor Potential (MTP) techniques used to describe the potential surfaced of materials. The development of a force field using AI and MTP techniques facilitates the delineation of the material properties of steel and graphite, two elements widely used in golf shaft manufacturing. The training procedure starts with collecting information on energy and energy-related data (force and stress) through quantum mechanics calculations. Subsequently, a polynomial-based expansion of machine learning is used to generate the AI potential. The implementation incorporated a BFGS minimization protocol. The data is segmented into training and validation sets, preceding a comparative analysis of AI and MTP potential predictions against those calculated via quantum mechanics. The findings of this study have the potential to shape the future of golf club design and contribute to advancements in material science within the sport.

#64 – SOUTH POLE TELESCOPE'S DUTY CYCLE FOR TRANSIENT SCIENCE

Yashasvi Moon. Physics, Astronomy & Materials Science. Faculty Advisor: Prof. Joaquin Vieira (University of Illinois at Urbana-Champaign)

Recently, cosmic microwave background (CMB) experiments have opened the millimeter-wave (mm) regime of the electromagnetic spectrum to time-domain and multi-messenger astrophysics. The South Pole Telescope (SPT) is an arcminute-resolution CMB survey that has demonstrated transient detection capabilities at millimeter wavelengths. The third generation camera and survey for SPT, called SPT-3G, measures temperature and polarization for three bands, centered at 90, 150 and 220 GHz, and has detected a population of transient stellar flares. In this work, we have measured the duty cycle with which SPT observes the sky to measure the rate of transient events and determine the true periodicity of flaring sources.

#65 – THE STRUCTURAL AND MOLECULAR PROPERTIES OF CHITOSAN NANOPARTICLES DESIGNED FOR DRUG DELIVERY

Hyrum Harlow, Rejeena Jha, Mourad Benamara, Robert A Mayanovic. Physics, Astronomy and Materials Science. Faculty Advisor: Robert Mayanovic

Chitosan-based nanoparticles (CSNPs) are currently being investigated for their utility in drug delivery. Contained herein is an investigation of the structural, morphological, and molecular properties of CSNPs when synthesized using the ionic-gelation method and modified with PEO and PPG. Chitosan nanoparticles in the concentration range of 0.25 to 1.0 % w/v were prepared using ionic gelation. Functionalization was made of the 1.0 % w/v chitosan nanoparticles using polyethylene oxide (PEO) alone and using a diblock copolymer of PEO and polypropylene glycol (PPG). We determined the size, degree of crystallinity, molecular effects, and morphology using a combination of TEM, XRD, and FTIR. Transmission electron microscopy (TEM) revealed that the average nanoparticle size is 11.3 to 14.8 nm. Functionalization of CSNPs using PEO alone had no impact on degree of crystallinity, but functionalization with a combination of PEO and PPG resulted in a higher degree of crystallinity in 1% w/v CSNPs. FTIR confirmed incorporation of TPP in all nanoparticles and increased hydrogen bonding in the more crystalline nanoparticles.

#66 – A STUDY OF CHITOSAN NANOPARTICLES FUNCTIONALIZED WITH THE 77KS SURFACTANT AND DESIGNED FOR CANCER DRUG DELIVERY

Claudia H. Wala, Lana Janson, Hyrum I. Harlow, Markos A. Georgy, Robert A. Mayanovic. Physics, Astronomy and Materials Science. Faculty Advisor: Robert Mayanovic

Chitosan nanoparticles are currently being investigated for their utility in enhancing cancer drug delivery. A key aspect of the use of chitosan nanoparticles as drug delivery agents is pH responsivity in differentiated pH environments between normal and cancerous tissue. In this study, we used the 77KS surfactant as a pH-sensitive adjuvant for drug delivery via chitosan nanoparticles. The chitosan nanoparticles were synthesized using the ionic gelation method under room temperature conditions. The synthesis of 77KS followed a method previously described in a study by Vives et al.[1] The chitosan nanoparticles were functionalized with 77KS using a solution of tripolyphosphate (TPP) and 77KS. The functionalized nanoparticles are being characterized using X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR). The results from the characterization will be reported. [1] M.A Vives et al., Chemico-Biological Interactions, **118** (1999) 1-18.

#67 – QUALITY ASSURANCE, QUALITY CONTROL (QA/QC) IN WATER TESTING

Rebecca Horning, School of Earth, Environment and Sustainability, Faculty Advisor: Melida Gutierrez

The project objective was to investigate quality assurance and control for testing of water quality. Water quality parameters pH, alkalinity, and nitrate-N concentration were measured in two water samples: one from a local spring (Sequiota) and one from a shallow well in rural Lawrence County (Chesapeake). The precision and accuracy of those measurements were then confirmed, and checks were performed for any possible error introduced by contamination from the measuring equipment. Measuring alkalinity and pH together is an indirect method of determining the concentration of bicarbonate ions in the water, a natural component of the water in the limestone-rich Springfield Plateau. Nitrate-N is a contaminant added to water by waste (human and animal) and many fertilizers. The EPA considers nitrate-N concentrations above 10 mg/L unsafe for human consumption, and eutrophication begins at 4 mg/L. High levels of nitrate-N or upward trends in concentration over time would therefore be cause for concern.

#68 – EVOLUTION OF PLANT HARDINESS ZONES IN MISSOURI 1946 – 2015

Madalyn Bass, School of Earth, Environment and Sustainability. Faculty Advisor: Toby Dogwiler

Plant Hardiness Zones (PHZ) define the area that a plant species can tolerate. PHZs are determined by the averaging the extreme minimum annual temperature for a period of years. PHZs are listed on labels for household and garden plants bought by consumers at nurseries and stores and are meant to educate consumers on what plants are appropriate for their climate. Over recent decades PHZs have shifted northward with a warming climate. These shifts indicate that over time some species may no longer grow and thrive in Missouri while new species will become viable within the state. Previous PHZ maps have only gone back to approximately 1990. The goal of this study was to obtain the necessary data and work out the methodology for creating PHZ maps for periods earlier than 1990. We analyzed Missouri weather stations from Conception, Kirksville, Hannibal, Booneville/New Franklin, Appleton City, Rolla, Springfield, Jackson, Ozark Beach, and Polar Bluff. The data from these weather stations ranges from 1946 – 2015 and was processed using a 30-year averaging window shifted forward in 10-year increments. We observe that PHZs have shifted north in Missouri with Zone 5a no longer present and Zone 7b having extended northward into southern Missouri.

#69 – NOT TOO SMALL TO MAKE A DIFFERENCE: NATURAL RESOURCE EDUCATION IN ZAMBIAN PRIMARY SCHOOLS.

Sarah Tuck. School of Earth, Environment and Sustainability. Faculty Advisor: Asif Ishtiaque.

Zambia holds access to key mineral resources, as well as water supplies, that support numerous Sub-Saharan African Countries. This study aims to reveal disparities in education of water and mineral sources between rural and urban settings within Zambia. The study was brought to life by a team from Missouri State University that conducted voluntary interviews with primary school students in the sixth and seventh grade in two of Zambia's provincial capitals, Livingstone and Chipata. Students answered three questions; the data were analyzed to determine the total number of students with "full knowledge," "partial knowledge," and "no knowledge," of Zambia's natural resources. The data collected revealed that, out of the 832 credible interviews, most of the students have at least partial knowledge of natural resources in both provinces

#70 – NAVIGATING CHANGE: UNDERSTANDING PUBLIC PERCEPTION OF URBAN REDEVELOPMENT AT A BUSY STREET CORNER OF A HISTORIC NEIGHBORHOOD

Ryan Griffin, Morgan Harriman, Ben Holland. School of Earth, Environment and Sustainability. Faculty Advisor: Ron Malega.

This project aims to better understand public concerns over the proposed redevelopment plans of a busy intersection within a historic neighborhood which garnered criticism from some neighborhood residents. Plans for redevelopment involve transforming an area of the neighborhood where a long-standing, yet vacant, single-family home stood to a mix of commercial and retail space. We conducted a nonrepresentative survey of residents to gauge their feelings about the proposed development and solicit their recommendations for the neighborhood's future.

#71 – WATER QUALITY OF DRINKING WATER SOURCES IN BLUEFIELDS BAY, JAMAICA

Samuel Booth. School of Earth, Environment and Sustainability. Faculty Advisor: Robert Pavlowsky

Water quality of different drinking water sources was evaluated for the coastal communities in Bluefield, Jamaica. Water was tested from the Bluefields River, karst springs, public water intake, tap water, and roof-top rainwater catchments. A field probe was used to measure pH, specific conductance (µS) to indicate dissolved solids, and temperature. A colorimetric indicator was used to test for the presence of total bacteria with blacklight fluorescence used to indicate E. Coli. Water pH varied with river and tap water at pH 7-8, springs at pH 7.1, and rainwater catchments ranging from pH 5.6 to 8 with higher pH closer to the sea at lower elevations indicating sea salt influence. Specific conductance was higher for water in contact with limestone and soil at >300 µS, while rainwater from catchment tanks were more dilute at 20-80 µS. Bacterial presence was indicated in many samples across water sources, but not public tap water. E coli fluorescence occurred in spring ponds, but goat grazing is common. More frequent bacteria testing through community groups using standard methods to confidently determine E. Coli risk. But this study suggests that spring ponds and some rainwater catchments may be vulnerable to bacterial contamination.

#72 – CORAL HEALTH ON MOOR REEF ALONG JAMAICA'S SOUTHCOAST

Jaime Kohrs. School of Earth, Environment and Sustainability. Faculty advisor: Bob Pavlowsky

Coral health has been declining worldwide since the 1980s. Caribbean reefs have been particularly affected by ocean warming, pollution, and human disturbances. However, more assessments are needed to better understand the extent of the problem. This study inventoried coral health indicators on Moor Reef, a patch reef about 100 m in diameter located 1,200 m offshore near Belmont, Jamaica. Transects along the windward and leeward sides of the reef were sampled using underwater GPS cameras at 5-meter intervals. The photographs were visually analyzed for bleaching, coverage by substrate, algal overgrowth, and water clarity. Ecological factors that affect coral health such as presence of fish, urchins, and snails were also taken into consideration, as they influence the water quality, rate of algal overgrowth, and substrate health. Overall, coral health was worse on the side furthest from mainland Jamaica, showing greater amounts of algal overgrowth and substrate coverage, as well as poorer water clarity. Furthermore, the families, genus, and species of coral that showed the best health were those known to be resistant to nutrient pollution and warming, suggesting that those stressors are negatively affecting Moor Reef.

#73 - LAND USE TRENDS AND HUMAN IMPACTS ALONG TREASURE BEACH, JAMAICA

Jeff Steinkamp. School of Earth, Environment and Sustainability. Faculty Advisor: Bob Pavlowsky

This study investigates the effects of human impacts and development along Treasure Beach on the south coast of Jamaica which is vulnerable to erosion and coastal flooding due to sea level rise and hurricanes. This study focuses on understanding land use change along the southern 2.5 km of Treasure Beach including Calabash Bay and Great Bay. Historical imagery from four time periods from 2003 to 2021 was analyzed using GIS software to identify development trends. Artificial beach features (fences, stairs, & walls) were located using GPS. Residential development has been increasing since 2003. With 12,357 m^2 of structures in 2003, the developed area increased each year by 1,555 m^2 (13%) in 2005, 2,553 m^2 (18%) in 2014, and 3,889 m^2 (24%) in 2021, totaling a 49% increase since 2003. Fences and walls occurred along 47% (18 properties) of Calabash Bay and 34% (7 properties) of Great Bay. Poorly planned development can result in habitat and beach loss due to the increasing risk of sea level rise and future storm events while also negatively impacting tourism and the local economy.

THE JUDGES

Biology

Ecology/Wildlife/Conservation
Bryan Simmons, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service
Lloyd Morrison, Ecologist, National Park Service

Cell Biology/Microbiology/Genetics
John C. Kincaid, Laboratory Microbiologist, Simmons Food
Jessica Reel, Cox Lab, PhD candidate, University of Oklahoma Health and Science Center

Chemistry

Geoffrey Manani, Lead Chemist, Rhomar Water
Melinda Sutton, R&D Chemist, Gem Gravure

Computer Science

Kirk Strauser, Chief Security Architect, Coda
Rich Miller, Retired Chief Information Officer

Cooperative Engineering

Damien Burbage, Planning Engineer, Transmission Planning, AECI
Jeremey Orf, Engineer, Toth and Associates

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

Whitney Vermillion, Business Intelligence Engineer, Ameren
Carissa Jones, Senior Scientist, Brewer Science

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

- **Giorgia Auteri** - Population Genetics, Conservation, Bats
- **Paul Durham** – Cell Biology, Neurobiology
- **Debra Finn** – Stream Ecology
- **Brian Greene** – Herpetology, Ecology
- **Kyoungtae Kim** – Cell Biology, Molecular Genetics
- **La Toya Kissoon-Charles** – Wetland Ecology, Wetland Plants
- **Laszlo Kovacs** – Genetics, Grapevine Biology
- **Day Ligon** – Physiology, Herpetology
- **Sean Maher** - Mammalogy, Ecology
- **Alicia Mathis** – Behavioral Ecology, Herpetology
- **Jay McEntee** – Evolution of Bird song
- **Babur Mirza** - Environmental Metagenomics, Microbial Ecology, Bioremediation
- **Quinton Phelps** – Applied Fisheries management
- **Avery Russell** – Plant-insect interactions
- **Georgianna Saunders** – Biology Education
- **Alexander Wait** – Plant Ecology, 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** - Chemical Education Research
- **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; physical methods of investigations of chemical compounds; x-ray crystallography
- **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, Nanomaterials-Plant Interactions, Ecological Effects of Nanomaterials
- **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 films and emulsions
- **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** - Analytical Chemistry, Nanomaterials in Sensing, Biological and environmental applications
- **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, Paper-based Analytical Device, Protein and Peptide Science, Polymer Chemistry

COMPUTER SCIENCE

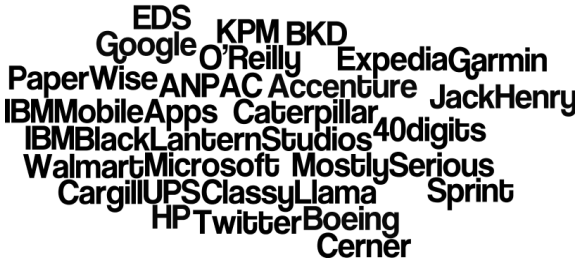
Computer science is a technology-oriented discipline whose fundamental principles combine theory, abstraction, and design. A solid foundation in the fundamental principles is critical to continued learning and adaptation to the technological changes which occur so rapidly in this discipline. The department 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
- **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 Physis based Modeling, Algorithms
- **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
- **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

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. Abdulaziz Abutunis** - 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
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
Oana Nelson
Carolyn Shand-Hawkins
Gary Stafford
Linda Sun
Kimberly Van Ornum
Fan Zhou

PHYSICS, ASTRONOMY & MATERIALS SCIENCE

The Physics, Astronomy, and Materials Science Department is committed to excellence in teaching, research, and service in each of our disciplines, which allows us to provide the best possible learning environment for our undergraduate and graduate students. We offer a wide range of courses, from introductory level to advanced. Our faculty members are deeply involved in research activities that include neural networks, the scholarship of teaching, the astrophysics of pulsating stars, energy, and the fabrication and development of nanotechnology devices. Department members provide community service at the local, regional, and national levels.

CURRENT RESEARCH

- **Andrzej Baran** - Age of and distances to open clusters; asteroseismology of pulsating stars; orbital analysis of binary systems
- **Tiglet Besara** - Design, Synthesis, and Characterization of Novel Inorganic Materials
- **David Cornelison** – Laboratory Astrophysics
- **Kartik Ghosh** - Growth and Characterization of Nanostructured Spintronic Materials
- **Shyang Huang** - Growth of Spintronic Materials using MBE, Scanning Tunneling Microscope
- **Robert Mayanovic** - Studies of Materials and Nanomaterials under Extreme Conditions
- **Saibal Mitra** – Nanoscale Materials and Devices like Nanosensors, Nanobatteries, Photovoltaic Materials
- **Daniel Moreno-German** - Electrochemical CO2 utilization, energy storage, and adsorption thermodynamics
- **Sarah Morrison** - Orbital Dynamics and Evolution of Extrasolar Planetary Systems
- **Emmett Redd** – Optical Neural Networks
- **Michael Reed** - Asteroseismology of late evolution compact pulsating stars
- **Devon Romine** – Computational modeling of materials
- **Ridwan Sakidja** – Computational Materials Science, High Temperature Materials, Protective Coatings, Materials Genome

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** - Stable isotope geochemistry and paleontology
- **Melanie Carden-Jessen** – Earth Science Education and Assessment
- **Toby Dogwiler** – UAV-based Remote Sensing, UAV operations, Structure-from-Motion Photogrammetry, Geospatial Analysis
- **Kevin Evans** - Paleozoic Carbonate Stratigraphy, Impact Geology
- **Krista Evans** - The Tiny House Movement, Rural Geography, Vernacular Architecture
- **Emily Frazier** – Human Geography, forced migration and displacement, refugee resettlement, qualitative methods
- **Doug Gouzie** - Cave and Karst Systems; Geologic Carbon Sequestration
- **Melida Gutierrez** – Environmental Geochemistry
- **Asif Ishtiaque** – Climate change and Sustainability
- **Tasnuba Jerin** – Fluvial geomorphology, Biomorphology, Watershed Hydromorphology, anthropogenic and climate change impacts on fluvial systems and watersheds
- **Jun Luo** - Geographic Information Science
- **Ron Malega** - Human geography, urban planning, quantitative methods in geography and planning
- **Matt McKay** – Structural Geology and Tectonics
- **Xin Miao** – Remote Sensing, Invasive Species
- **Gary Michelfelder** - Volcanology, Igneous Trace Element and Isotope Geochemistry, Mineral Chemistry
- **Kevin Mickus** - Geophysics, Tectonics, Remote Sensing
- **Bob Pavlowsky** – Geomorphology, Hydrology, Water Quality; Ozark rivers and Urban Watersheds
- **David Perkins** - Weather, Climate & Society; Sustainable Tourism; Tourism Geographies
- **Xiaomin Qiu** – Graphical Representation of Spatial Data
- **Chuck Rovey** - Hydrogeology, Sedimentology, Glacial Stratigraphy; Geologic Carbon Sequestration

2023 CNAS Virtual Undergraduate Research Symposium Winners

Biology: Ecology, Wildlife and Conservation

1st Place: *Taylor Hiers*
A NOVEL APPROACH TO SCORING RHYTHMIC VARIATION IN EVOLVING WHITE-THROATED SPARROW (ZONOTRICHIA ALBICOLIS) SONGS
Faculty Advisor: Dr. Jay McEntee

2nd Place: *Gabriela Rivero*
THE PHENOLOGY OF A FEMALE CAROLINA WREN CALL HELPS ELUCIDATE ITS FUNCTION
Faculty Advisor: Dr. Jay McEntee

Biology: Cellular, Microbiology and Genetics

1st Place: *Emma Braun*
BIOCHEMICAL STUDY OF CHARACTERIZING THE INTERACTION BETWEEN QUANTUM DOTS AND ACTIN
Faculty Advisor: Dr. Kyoungtae Kim

2nd Place: *Daniel Garten, Sophia Antonpoulos, Sara Woodman.*
DIETARY GRAPE SEED EXTRACT SUPPLEMENTATION INHIBITS NOCICEPTION AND MEDIATES GABAERGIC CHANGES IN A PRECLINICAL MODEL OF CHRONIC TMD
Faculty Advisor: Dr. Paul Durham

Chemistry and Biochemistry

1st Place: *Maximo Reyes, Jessica Linson, Preston Clubb, Martin Winburn, Barry Cheung.*
EFFECTS OF ATMOSPHERIC PLASMA TREATMENT ON THE TOXICITY OF POLYSTYRENE NANOPLASTICS IN WHEAT (TRITICUM AESTIVUM L.)
Faculty Advisor: Dr. Cyren Rico

2nd Place: *Krusha Bhakta*
STUDIES OF BACKBONE INTERCONVERSION AND DYNAMIC PROPERTIES IN DNA VIA NMR.
Faculty Advisors: Dr. Gary Meints

Computer Science

1st Place: *Gavin Moore, C.J. Moore*
AN EVOLUTIONARY MULTI-AGENT POLICY OPTIMIZATION FRAMEWORK USING SELF-ADVERSARIAL TRAINING SCENARIOS
Faculty Advisor: Dr. Siming Liu

2nd Place: *Nathan Hartzler, Brenna Dove, Nat Thompson, Joshua Stevens, Ingrid Perkins*
COMBINING MULTIPLE DEEP LEARNING MODELS FOR ONLINE SARCASM DETECTION
Faculty Advisors: Dr. Mahammed Y. Belkhouche

Cooperative Engineering

1st Place: *Joshua Cox*
THE EFFECT OF TEMPERATURE ON ELECTROCHEMICAL REDUCTION OF CARBON DIOXIDE AND FORMATE PRODUCTION
Faculty advisors: Dr. Daniel Moreno

2nd Place: *Stephen Davis, Austin Crabtree, Justin Leuthauser*
AUTO LAWN: WEBPAGE CONTROLLED YARD DEVICES
Faculty Advisors: Dr. Rohit Dua

Geology

1st Place *Oluchi Nweke*
SEQUIOTA CAVE SPRING AND POND INFLUENCE ON WATER QUALITY IN GALLOWAY BRANCH, SE SPRINGFIELD, MO
Faculty advisor: Dr. Bob Pavlowsky and Hannah Bieser (OEWRI RA)

2nd Place: *Abby Momberg*
CAN BOOKS BE TOXIC? AN XRF ANALYSIS OF ARSENIC CONTENT IN BOOK COVERS FROM MEYER LIBRARY SPECIAL COLLECTIONS
Faculty Advisors: Dr. Doug Gouzie

Geography, Geospatial and Planning

1st Place: *Genevieve Stark, Katherine Rudolph*
WHO WELCOMES REFUGEES? REFUGEE RESETTLEMENT AGENCIES AND THIRD SECTOR ORGANIZATIONS IN THE SOUTHEASTERN U.S.
Faculty advisor: Dr. Emily Frazier

2nd Place: *Allison Gargus*
BEACH EROSION TRENDS AT CRAB POND POINT SEA TURTLE NESTING SITE, SOUTHWEST COAST, JAMAICA
Faculty Advisors: Dr. Bob Pavlowsky and Hannah Lowery (OEWRI RA)

Hospitality Leadership

1st Place: *Madison Smith, Alyson Morgans, Jake Boaz, Dodgle Schapeler*
DESTINATION IMAGE OF KANSAS CITY FROM THE PERSPECTIVE OF GENERATION Z
Faculty Advisor: Dr. Nancy Kageyama

Mathematics

1st Place: *Grace Herbold, Jake Gabbert*
DEVELOPING FRACTION-AS-MEASURE CONCEPTIONS TO SUPPORT GROWTH IN STUDENTS' ALGEBRAIC REASONING CAPACITIES IN MATH 101
Faculty Advisor: Dr. Patrick Sullivan

Physics, Astronomy and Materials Science

1st Place: *Matthew Bruenning*
IMPLEMENTATION OF A HOUGH TRANSFORM ON A FIELD PROGRAMMABLE GATE ARRAY
Faculty Advisor: Dr. Tiglet Besara

2nd Place: *Rachel Lee*
DEVELOPMENT OF ARITIFICIAL INTELLIGENCE-BASED FORCEFIELDS TO MODEL TUNNEL BARRIERS IN SUPERCONDUCTIONG QUBITS
Faculty Advisor: Dr. Ridwan Sakidja

CNAS Accelerated Masters Programs

The Accelerated Master's degree option provides a transition that enables outstanding Missouri State undergraduate students to begin taking graduate course work in their senior year and thus combine components of the undergraduate and graduate curriculum.

Eligible undergraduate students may apply for preliminary acceptance into an accelerated master's program after the specific program admission requirements have been met. If accepted, a maximum of 9-12 credit hours of approved graduate level courses may be designated as "mixed credit" and count towards both the undergraduate and graduate degree programs as specified in the accelerated program requirements.

Graduate programs offering an accelerated option in the College of Natural & Applied Sciences are:

- **Biology** (MS)
- **Chemistry and Biochemistry** (MS)
- **Computer Science** (MS)
- **Geography and Geology** (MS)
- **Materials Science** (MS)
- **Mathematics** (MS)
- **Secondary Education in Mathematics** (MSEd)
- **Natural & Applied Science** (MNAS)

Undergraduate students interested in the Accelerated Master's opportunity should contact their department or the Graduate College, GraduateCollege@MissouriState.edu (417-836-5335) to determine admission requirements and procedures, https://graduate.missouristate.edu/futurestudents/Accelerated.htm