

17th ANNUAL CNAS UNDERGRADUATE SYMPOSIUM



THURSDAY, APRIL 16, 2026

9:00 AM – 12:00 PM

PLASTER STUDENT UNION

STUDENT POSTERS DISPLAY

9:00 AM to 12:00 PM

PSU Ballroom

CNAS RESEARCH IN:

SCIENCE

TECHNOLOGY

ENGINEERING

MATHEMATICS

SPEAKER & AWARDS:

3:00 – 4:30 PM

Roy Blunt Hall 101

SPEAKER:

Dr. Songfeng Zheng

Mathematics Department

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Tamera Jahnke, Dean

Jorge Rebaza, Associate Dean

Kyoungtae Kim, Biology Department Head

Adam Wanekaya, Chemistry & Biochemistry Department Head

Ajay Katangur, Computer Science Department Head

Theresa Odun-Ayo, Cooperative Engineering Program Director

Gary Michelfelder, School of Earth, Environment & Sustainability Director

William Bray, Mathematics Department Head

Robert Mayanovic, Physics, Astronomy & Materials Science Department Head

Guest Speaker Dr. Songfeng Zheng is the 2025 recipient of the Atwood Research and Teaching Award and is a Professor in the Missouri State University Mathematics Department



SEVERAL OPTIMIZATION ALGORITHMS WITH APPLICATIONS IN STATISTICS

Abstract

Optimization algorithms are an important component in engineering and science projects. In this talk, we will briefly review several optimization ideas including gradient descent, majorization-minimization, and iteratively reweighted least square. As examples, we will show their applications in various statistical models.

About Dr. Songfeng Zheng

Dr. Songfeng Zheng's research interests include both theoretical and applied statistics. On the theoretical side, Dr. Zheng is interested in classical mathematical analysis, probability inequalities, and the generalization of error bounds of machine learning models. On the applied side, Dr. Zheng's interests lie in computational statistics, statistical modeling for high dimensional data, especially for variable selection in high dimensional data, machine learning models and pattern recognition, and the applications of machine learning to image analysis and bioinformatics. Since joining MSU, Dr. Zheng has published 25 peer reviewed papers on academic journals and another 4 papers on various international conferences.

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 the University of Alabama in 1967 but has been the department head at the 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.

THE JUDGES

Biology

Ecology/Wildlife/Conservation

Dr. Giorgia Auteri, Senior Research Scientist, Bat Conservation International
Dr. Tom Tomasi, Biology Emeritus Faculty, MSU
Brianna Edwards, Research Scientist, OEWRI

Cell Biology/Microbiology/Genetics

Richard Wells, Biological Clinical Science Faculty, OTC
Dr. Ram Nayar, Microbiology Emeritus Professor

Chemistry

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

Computer Science

Kirk Jones, Software Engineer, Black Flame LLC
Aaron Ogle, Data Engineer, City Utilities of Springfield
William Padfield, Senior Data Scientist, Husch-Blackwell

Cooperative Engineering

Nathaniel Van Devender, Engineer, AECI
Benjamin Cuebas, Engineer, Honeywell

School of Earth, Environment and Sustainability

Geology

Molly Starkey, Environmental Assistance Unit, Missouri Geological Survey
Drew Laviada-Garmon, Geophysicist, Terracon

Geography/Geospatial/Planning

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

Mathematics

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

Physics, Astronomy & Materials Science

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

High School Division

Mikayla Scharnhorst – Biology, Graduate Student, Missouri State University
Jordan Murray – Biology, Graduate Student, Missouri State University

POSTER TITLES 2026

BIOLOGY	
BIOLOGY: ECOLOGY, CONSERVATION AND WILDLIFE	
1	<p>WINNER/LOSER EFFECTS AND COMPETITIVE DOMINANCE IN CONVICT CICHLIDS Sophie Bryan. Faculty Advisor: Kathleen Church</p>
2	<p>METABOLIC DIFFERENCES IN CONVICT CICHLID DOMINANCE HIERARCHIES. Alex Kean. Faculty Advisor: Kathleen Church.</p>
3	<p>ALGAE ON THE MOVE: HOW DEPTH AND SPATIAL VARIATION INFLUENCE ALGAE COMMUNITY COMPOSITION IN LAKE SPRINGFIELD Alex Geeslin and Teressa Kruit. Faculty Advisor: La Toya Kissoon-Charles.</p>
4	<p>POLLUTION TOLERANT AND SENSITIVE MACROINVERTEBRATES PERSIST IN A MINING-CONTAMINATED SOUTHWEST MISSOURI STREAM Riley Cook, Malachai Frisby, Leslie Hatch, Trang Tran. Faculty Advisor: La Toya Kissoon-Charles</p>
5	<p>FROSTY FRONDS: IMPLICATIONS OF <i>AZOLLA CAROLINIANA</i> RESILIENCE TO MILD WINTERS IN LAKE SPRINGFIELD. Sarah Guymon, Anna Schwarm, Jaslyn Johnson, Anna Faust. Faculty Advisor: La Toya Kissoon-Charles.</p>
6	<p>NASTY WATERS AND PARADOXICAL PLANKTON: ALGAL SEASONAL VARIATION AND SPECIES DIVERSITY IN THE LITTORAL ZONE OF LAKE SPRINGFIELD, MO. Teressa Kruit and Alex Geeslin. Faculty Advisor: La Toya Kissoon-Charles</p>
7	<p>DIVING PATTERNS OF AN AQUATIC BIOMODALLY RESPIRATING TURTLE Alex Rapp. Faculty Advisor: Day Ligon.</p>
8	<p>DIVING BEHAVIOR AND VOLUNTARY SUBMERSION TIMES OF A TROPICAL SEMIAQUATIC TURTLE IN BELIZE Ellie DeCarlis. Faculty Advisor: Day Ligon.</p>
9	<p>HYPORHEIC RESILIENCE: INVERTEBRATE COMMUNITIES MINIMALLY AFFECTED BY VARIABLE CHANNEL STABILITY ALONG A GRAVEL-BED RIVER Connor Bruemmer, Korinna Brandt, Marc Owen. Faculty Advisor: Debra S Finn.</p>
10	<p>INFLUENCES OF FISH ON VARIOUS AQUATIC EMERGENT INSECT TAXA ADULT BODY SIZE IN TWO SMALL, NON-PERENNIAL STREAMS. Lily A. Smith, Tanner L. Conwell, Connor Bruemmer. Faculty Advisor: Debra S. Finn.</p>

11	HOW DOES URBANIZATION INFLUENCE ECOLOGICAL STREAM FUNCTIONALITY? Brynn E. Kayhill, Lily A. Smith. Faculty Advisor: Debra S. Finn
12	BOBBING, BENDING, DIPPING, TILTING – WHAT ARE THESE BIRDS DOING AND WHY? Dalton Brown. Faculty Advisor: Nadjé Najar
13	TIME OF DAY DOES NOT AFFECT FEEDING LATENCY OR SWIMMING PERFORMANCE OF NORTHERN COTTONMOUTH SNAKES Sam Walker-Schaefer and Olivia Hoffner. Faculty advisor: Brian Greene.
14	FLOWERING PLANT ENDEMICITY IN TALLGRASS PRAIRIES INCREASES BUMBLE BEE COMMUNITY HEALTH Maev Winchester, Kendra N. Edge, Anthony M. T. Castagna, Charlotte C. Davis, Rita N. Afagwu, Leo P. Carpenter, Success C. Ekemezie, Jenny K. Burrow, James D. Bynum, Ashley N. White, Kierstin C. I. Howard, Tabitha Moul. Faculty advisor: Avery L. Russell.
15	BERRY IMPORTANT POLLINATORS: EVALUATING THE ROLE OF ARTHROPODS IN POLLINATION OF THE AMERICAN ELDERBERRY Jenny K. Burrow, Katelin M. Meek, Anthony Moth T. Castagna, Oscar V. Peterson, Ashley N. White, Maev Winchester, Alaina K. Morrissey, James D. Bynum, Caleb S. O’Neal, Andrew L. Thomas. Faculty advisor: Avery L. Russell.
BIOLOGY: CELLULAR, MICROBIOLOGY AND GENETICS	
16	EFFECT OF TIRE WEAR PARTICLE 6PPD AND 6PPDq ON HepG LIVER CANCER CELL METABOLISM Magdalena Singleton, Emma Bruan. Faculty Advisor: Kyoungtae Kim.
17	DOXORUBICIN-LOADED CHITOSAN NANOPARTICLES: ENHANCING STABILITY AND TARGETED ANTICANCER ACTIVITY Madi Frerichs, Abhishu Chand, Lana Jane Janson, Moupia Tajrin Oyshi, Mohammad Galib. Faculty Advisor: Kyoungtae Kim and Robert Mayanovic.
18	A COMPREHENSIVE STUDY OF QUANTUM DOTS INTERACTIONS WITH ACT AND AN ACTIN BINDING PROTEIN Elijah Billue, Abhishu Chand, Nhi Le, Tony Astuhuaman. Faculty Advisors: Kyoungtae Kim and Ridwan Sakidja.
19	DETECTION OF TETRACYCLINE RESISTANT BACTERIA IN SOIL SAMPLES Erin Hachez, Colbie Allison. Faculty Advisor: Will Sewell.
20	GREEN ALTERNATIVE SYNTHESIS OF EDARAVONE THROUGH A SULFITE/BISULFITE SYSTEM Chadd Huffman. Faculty Advisor: Patrick Casey
21	CHARACTERIZATION OF TRIGEMINAL GANGLION ORGANOID CULTURES Amelia Easterling, Ania Kovacs, Nicole Nalley. Faculty Advisor: Paul Durham.

22	CALCITONIN GENE-RELATED PEPTIDE AND GRAPE SEED EXTRACT DIFFERENTIALLY MODULATE EXPRESSION OF PROTEINS IN TRIGEMINAL GANGLION NEURONS AND GLIA Ania Kovacs, Nicole Nalley, Amelia Easterling. Faculty Advisor: Paul Durham.
23	TRANSIENT TEMPOROMANDIBULAR JOINT HYPEREXTENSION IS ASSOCIATED WITH ALTERED FEEDING BEHAVIORS: SUPPRESSION BY GRAPE SEED EXTRACT Colleen Myers, Mikayla Scharnhorst, Donovan Aardema Faigh. Faculty Advisor: Paul Durham.
24	TRANSIENT HYPEREXTENSION OF THE TEMPOROMANDIBULAR JOINT IS ASSOCIATED WITH CHANGES IN GABAERGIC PROTEINS IN THE SPINAL TRIGEMINAL NUCLEUS: SUPPRESSION BY DIETARY SUPPLEMENTATION WITH GRAPE SEED EXTRACT Monique Fiagan, Colleen Myers, Mikayla Scharnhorst, Donovan Aardema Faigh. Faculty Advisor: Paul Durham.
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26	A PATHWAY TOWARDS UNDERSTANDING THE ORIGINS OF LIFE: INVESTIGATING L-AMINO ACID DOMIANCE IN BIOLOGICAL SYSTEMS Kyle Ramaker. Faculty Advisor: Keiichi Yoshimatsu
27	SYNTHESIS AND CHARACTERIZATION OF PT-CYCLOHEXYLAMIDE CYANOXIMATES C. Mitch Lindner. Faculty Advisor: Nikolay Gerasimchuk
28	INVESTIGATING HEMAGGLUTININ-MEDIATED INFLUENZA BINDING AND FUSION USING MAGNETIC LIPOSOME NANOSENSORS Emilee Dees, Justin Reiner, Jacklyn White. Faculty Advisors: Tuhina Banerjee and Santimukul Santra
29	KINETIC ANALYSIS AND STRUCTURAL CHARACTERIZATION OF CERIUM OXIDE NANOPARTICLES Amoakoa Owusu Yeboah. Faculty Advisor: Tuhina Banerjee.
30	CHARACTERIZATION OF BERGAMOT EXTRACTS AND THEIR INHIBITORY EFFECTS ON HMG-CoA REDUCTASE Alaina Worland. Faculty Advisor: Natasha DeVore.
31	THERMOSTABLE GREEN PROTEIN E144H MUTATION'S IMPROVEMENT OF COPPER AFFINITY. Madison Guetzkow and Morgan Brill. Faculty Advisor: Natasha DeVore.
32	STRUCTURAL INVESTIGATION OF COPPER BINDING SITES IN A THERMOSTABLE GREEN FLOURESCENT PROTEIN Morgan Brill and Madison Guetzkow. Faculty Advisor: Natasha DeVore.

33	EFFECTS OF P145 DELETION ON THERMOSTABLE GREEN PROTEIN ANALOG PERFORMANCE. Avery Elliott. Faculty Advisor: Natasha DeVore.
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34	SCALABLE POLYNOMIAL INTERPOLATION VIA MAPREDUCE AND A NEW RECURRENCE-BASED QUOTIENT-RING INTERPOLANT Christopher Housholder. Faculty Advisor: Hazhar Rahmani
COOPERATIVE ENGINEERING	
35	DISCRETE INDUCTIVE WIRELESS POWER TRANSFER FOR LOW-POWER DEVICES Kristin Burdin, Elijah Totten, and Jonathan Ross. Faculty Advisor: Theresa Odun-Ayo
36	GREEN ENERGY HARVESTING THROUGH SMALL-SCALE GENERATORS FOR PERSONAL USE Austin Miller, Cody Busch, Parker Smith. Faculty Advisor: Theresa Odun-Ayo
37	HOMEEDEN SPROUT: ITERATIVE DESIGN OF AN AUTOMATED HOUSEPLANT WATERING SYSTEM Tyler Mills, Brandon Butler. Faculty Advisor: Dr. Theresa Odun-Ayo.
38	POLLUTION PREVENTION IN MISSOURI INDUSTRY: AN EPA-FUNDED INITIATIVE Rebecca Grant. Advisors: Sanjay Tewari and Doug Neidigh.
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39	SPATIAL-TEMPORAL NONLOCAL TRAFFIC DYNAMICS: ANALYTICAL PROPERTIES, ADAPTIVE KERNEL FORMULATION, AND EMPIRICAL VALIDATION Christopher Housholder. Faculty Advisor: Animesh Biswas
40	THE ROOTS OF DISAGREEMENT Christopher Housholder. Faculty Advisor: Steven Senger
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43	SNOWLINE GIANT PLANET PERTURBATIONS AND HABITABLE ZONE PLANET STABILITY Bishwash Devkota. Faculty Advisor: Sarah Morrison.
44	GRAVITATIONAL WAVE CLASSIFICATION WITH QUANTUM KERNEL SVMs FOR MULTI-MESSENGER ASTRONOMY Bishwash Devkota. Faculty Advisor: Ridwan Sakidja.

45	QUANTUM REINFORCEMENT LEARNING FOR PORTFOLIO OPTIMIZATION Asher Van Maanen. Faculty Advisor: Ridwan Sakidja
46	QUANTUM REINFORCEMENT LEARNING FOR ROUTE OPTIMIZATION: ADAPTING A CATALYST SELECTION FRAMEWORK TO THE TRAVELLING SALESMAN PROBLEM Henry Hare. Faculty Advisor: Ridwan Sakidja.
47	QUANTUM KERNEL SUPPORT VECTOR MACHINES FOR MULTI-CLASS TRANSIENT CLASSIFICATION Armitha Dutta. Faculty Advisor: Ridwan Sakidja.
48	PROBING THE NANO-BIO INTERFACE: STUDYING THE INTERACTIONS BETWEEN NANOPARTICLES AND BIOMOLECULES Armitha Dutta. Faculty Advisor: Kartik Ghosh.
49	CLIMATE IMPLICATIONS FOR HABITABLE ZONE PLANETS IN SYSTEMS CONTAINING A NEARBY JUPITER Armitha Dutta. Faculty Advisor: Sarah J. Morrison.
50	FORMULATING CHITOSAN NANOPARTICLES LOADED WITH DOXORUBICIN AND A 77KS ADJUVANT FOR CANCER DRUG DELIVERY Lana Janson, Faith Sheridan, Wade Van Riessen, Markos A. Georgy, Abhishu Chand. Faculty Advisors: Kyoungtae Kim and Robert A. Mayanovic.
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SEES: GEOLOGY	
51	LITHOSPHERIC STRUCTURE CONTROLS GEOCHEMICAL DIVERSITY ACROSS THE TERCEIRA RIFT, AZORES TRIPLE JUNCTION Angel Doran. Faculty Advisor: Gary Michelfelder.
52	FLUORINATED PYROCHLORE FOUND IN SYENITE EJECTA FROM AGUA DE PAU VOLCANO, SAO MIGUEL ISLANDS, AZORES ARCHIPELAGO Zackary Rouser, Angel Doran. Faculty Advisor: Gary Michelfelder, Fei Wang.
53	FISH TEETH AS A RECORD OF PALEOENVIRONMENTS Alexis Capestro. Faculty Advisor: Lydia Tackett.
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54	THE IMPACTS OF FOOD INSECURITY IN THE OZARKS: LOW INCOME, LOW ACCESS RURAL COUNTIES December Wolf. Faculty Advisor: Krista Evans.
55	PROPERTY VACANCY IN THE CITY OF ST. LOUIS, MISSOURI Shey Delahunt. Faculty Advisory: Dr. Krista Evans.
56	THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL IMPACT OF COMMERCIAL POULTRY PRODUCTION IN THE OZARKS REGION

	Grace Wasson. Faculty Advisor: Krista Evans.
57	IMPACTS OF COST-OF-LIVING DRIVEN DOMESTIC MIGRATION ON FUTURE SUSTAINABILITY OF U.S. STATES Emma Coombs. Faculty Advisor: Emily Frazier
	HIGH SCHOOL DIVISION
58	WHAT DO MOBILE BAY SEDIMENTS CONTAIN? ESTIMATING ORGANIC MATTER USING LOSS-ON-IGNITION Jazmynn Brewer and Logan Wilson. McDonald County High School. Faculty Advisor: Keith Jones.
59	“IF [THEY] BE MR. HYDE, I SHALL BE MR. SEEK”: INVESTIGATING CRAWDAD POPULATION IN MCDONALD COUNTY Jayden Mustain. McDonald County High School. Faculty Advisor: Keith Jones.
60	GROWTH RATE OF FAXONIUS LONGIDGITUS UNDER CAPTIVE CONDITIONS Emma Cooper. McDonald County High School. Faculty Advisor: Keith Jones.
61	EVALUATING PATTERN-RECOGNITION SOFTWARE AS A TOOL FOR ANIMAL IDENTIFICATION Kaberlyn Burchett. McDonald County High School. Faculty Advisor: Keith Jones.
62	RESUSCITATION OF DORMANT MICROALGAE IN ALABAMA GULF SHORE SEDIMENT SAMPLES Ellie Allgood and Lilly Reaves. McDonald County High School. Faculty Advisor: Keith Jones.
63	THE SKIN MICROBIOME OF EURYCEA TYNERENSIS: IMPLICATIONS FOR AMPHIBIAN HEALTH IN THE OZARKS Dominick Trimble and Zoey Clower. McDonald County High School. Faculty Advisor: Keith Jones.
64	INTERSPECIES SOARING BEHAVIORS IN OZARK VULTURES DURING A RANGE EXPANION IN <i>CORAGYPSATRATUS</i> Abby Richards. McDonald County High School. Faculty Advisor: Keith Jones.
65	CHARACTERIZATION OF TGP-E H172S Brodie Mohler. Ozark High School. Faculty Advisor: Natasha Devore.

#1 WINNER/LOSER EFFECTS AND COMPETITIVE DOMINANCE IN CONVICT CICHLIDS

Sophie Bryan. Ecology, Conservation, and Wildlife. Faculty Advisor: Kathleen Church

Size-based dominance hierarchies are common throughout the animal kingdom. In a given social group, dominant individuals display more aggression towards conspecifics and often monopolize resources such as food. Smaller individuals are then unable to out compete larger ones and are the recipients of, rather than initiators of, aggression. However, other factors are involved, including prior competitive experience (i.e., winner/loser effects) and personality (i.e., individual, repeatable behavioral traits). In this experiment, captive-bred convict cichlids (*Amatitlania nigrofasciata*) experienced either a “winner” (being significantly larger than two cohoused conspecifics) or a “loser” condition (being significantly smaller than the two conspecifics) for one week, as well as repeated individual personality assays. Then, food consumption and aggressive behavior were observed in feeding trials in size-matched groups (N = 4 fish). This experiment investigated the relationships between prior experience, the consistency of individual personality traits, and social dominance among same-sized conspecifics. Preliminary results indicate that prior competitive experience influences future dominance in convict cichlids, but does not fully account for it without consideration of other factors such as personality.

#2 METABOLIC DIFFERENCES IN CONVICT CICHLID DOMINANCE HIERARCHIES.

Alex Kean. Ecology, Conservation, and Wildlife. Faculty Advisor: Kathleen Church.

Many animals use dominance hierarchies to control access to contested resources. Dominant individuals tend to gain priority resource access, and to asymmetrically exhibit aggressive behaviors towards subordinates. Dominance is often size based, with larger individuals generally outcompeting smaller individuals. However, other factors can affect dominance rankings, such as metabolic differences (i.e., SMR, MMR), as dominants often have higher energetic demands. In this study, groups of eight same-size convict cichlids were tagged with subcutaneous elastomer, then subdivided into groups of four fish. Each fish competed within four different subgroups for 10 consecutive days to evaluate the repeatability of dominance among different group members. Dominant fish were identified by their higher food consumption and greater number of chases toward conspecifics. Fish also underwent intermittent-flow respirometry for 24 hours after competing within each subgroup to evaluate the consistency of metabolic rate and its relationship to dominance status. Preliminary results show that the relationship between competitive dominance and metabolism tends to be complex and more variable than anticipated, and that dominant individuals do not always exhibit distinct differences in their metabolic rates relative to subordinate competitors.

#3 ALGAE ON THE MOVE: HOW DEPTH AND SPATIAL VARIATION INFLUENCE ALGAE COMMUNITY COMPOSITION IN LAKE SPRINGFIELD

Alex Geeslin and Teresa Kruit. Ecology, Conservation, and Wildlife. Faculty Advisor: La Toya Kissoon-Charles.

Algae are essential for nutrient cycling and aquatic food webs in lotic systems. Conversely, algae blooms can impair aquatic ecosystem function by reducing dissolved oxygen levels and limiting light penetration. Patterns of algae growth and distribution in lakes are shaped by nutrient availability, sunlight, temperature, depth, and water movement. High nutrient inputs, warm weather, and calm, shallow conditions promote algal blooms. Lake Springfield, a reservoir in the James River watershed in southwest Missouri, is known for frequent algal blooms due to high nutrient inputs and shallow depths. This study examines how variations in depth and space impact algae community composition. We hypothesized, as distance increases from inflow homogenization of algal communities would also increase. Every one to three months we collected surface water samples from different locations in Lake Springfield, to assess how distance from inflow is driving the unique assemblage of algal abundance. We did not observe homogenization in algal communities since Chlorophyta and Bacillariophyta varied in abundance among sample locations downstream from inflow. These taxa indicate depth and subsequent mixing could play important roles in the distribution and abundance of algae in Lake Springfield. Additional sampling and physicochemical measurements could clarify how reservoir characteristics impact algal community composition.

#4 POLLUTION TOLERANT AND SENSITIVE MACROINVERTEBRATES PERSIST IN A MINING-CONTAMINATED SOUTHWEST MISSOURI STREAM

Riley Cook, Malachai Frisby, Leslie Hatch, Trang Tran. Ecology, Conservation, and Wildlife. Faculty Advisor: La Toya Kissoon-Charles

Missouri's centuries-old mining industry created an abundance of metal pollution. Streams in the Tri-state Mining District have high metal concentrations which decreased macroinvertebrate densities and subsequently decreased organic matter decomposition and nutrient cycling. We performed leaf pack experiments (mesh <1mm) using American sycamore (*Platanus occidentalis*) leaves collected from trees upstream (non-contaminated) and downstream (contaminated) from old Pb-Zn mines in Christian and Greene counties. We placed packs in a reference and mining reach of Pierson Creek to examine macroinvertebrate colonization. We hypothesized that more macroinvertebrates would colonize the reference than the mining reach, and macroinvertebrates would prefer non-contaminated leaves over contaminated leaves. Preliminary findings indicated the reference had more macroinvertebrates than the mining reach. Surprisingly, the mining reach had a higher proportion of Ephemeroptera, Plecoptera, and Trichoptera (EPT) compared to the reference reach. These taxa are known to be pollution sensitive, but most EPT found in the leaf packs were taxa associated with mining contamination in other studies. These results agreed with our previous findings in Big River, a larger stream in Southeast Missouri impacted by large-scale mining pollution over a longer period. Our study illustrates streams near mines have decreased macroinvertebrate abundance, but tolerant EPT might persist in mining-contaminated streams.

#5 FROSTY FRONDS: IMPLICATIONS OF *AZOLLA CAROLINIANA* RESILIENCE TO MILD WINTERS IN LAKE SPRINGFIELD.

Sarah Guymon, Anna Schwarm, Jaslyn Johnson, Anna Faust. Ecology, Conservation, and Wildlife. Faculty Advisor: La Toya Kissoon-Charles.

Azolla caroliniana, a free-floating fern, enriches waters due to its symbiotic relationship with nitrogen-fixing bacteria. In winter, *Azolla* growth declines as it enters dormancy by sinking to bottom sediments. In spring through summer, growth increases with temperature as plant fragments resurface and resume asexual growth. In Lake Springfield, *Azolla* was first observed in fall 2020 and its abundance increased every year since. We observed its growth peaking in fall and declining in early winter. Variations in winter temperatures might influence these growth patterns. Our study will determine the impact of cold exposure on *Azolla* growth in lake water microcosms and subsequent changes in water nitrogen. We hypothesized that *Azolla* exposed to ≤ 0 °C will have decreased biomass and survival, leading to nitrogen increases due to nutrient release from decaying *Azolla*. We grew *Azolla* in water from Lake Springfield, exposed it to -5 °C, 0 °C, 5 °C, and 20 °C for 14 days, then grew it at 20 °C for 21 days. *Azolla* tolerated exposure to 5 °C but did not survive <0 °C. *Azolla* growth in different temperature treatments impacted water chemistry. Our findings imply that winter temperatures might impact growth and could inform management of locally adapted *Azolla*.

#6 NASTY WATERS AND PARADOXICAL PLANKTON: ALGAL SEASONAL VARIATION AND SPECIES DIVERSITY IN THE LITTORAL ZONE OF LAKE SPRINGFIELD, MO.

Teresa Kruit and Alex Geeslin. Ecology, Conservation, and Wildlife. Faculty Advisor: La Toya Kissoon-Charles

Lake food webs are driven by algae. However, excessive algal growth can degrade water quality by decreasing dissolved oxygen and water clarity. In early spring, algae respond to changing temperatures. Mild winters lead to quick increases in water temperatures in spring and warmer surface waters in summer and fall. This causes premature algal blooms in the spring and intensified blooms in the summer. Lake Springfield, a reservoir located within the James River watershed in southwest Missouri, has a history of algal blooms due to excess nutrients and shallow waters. Our goal was to determine how algal abundance and taxa richness vary with season in Lake Springfield. We hypothesized that algal abundance would increase in spring through fall and species richness would decrease. We assessed surface water samples collected from the littoral zone of Lake Springfield every 1-3 months over one year for taxa abundance and richness. Results indicated that algal abundance and richness were primarily influenced by season and sample location within the lake. These findings will increase our understanding of the impacts of seasonal variations on algal biodiversity in Lake Springfield and how algal abundance is influenced by the physical characteristics of reservoirs.

#7 DIVING PATTERNS OF AN AQUATIC BIOMODALLY RESPIRATING TURTLE

Alex Rapp. Ecology, Conservation, and Wildlife. Faculty Advisor: Day Ligon.

Dermatemys mawii is a critically endangered freshwater turtle species that inhabits parts of Central America. The species is unusually well adapted to aquatic living, yet little effort has been made to observe its diving patterns. We observed the diving behavior of 9 juvenile *D. mawii* to investigate tradeoffs between aerial respiration and voluntary submersion. Depth was standardized among individuals by filling an aquarium to 2x carapace length. Turtles were placed in their chamber 14 hours prior to each trial to allow time for acclimation; trials were conducted once per individual, and each ran for 8 hours. Trials were recorded and intervals of submersion versus surfacing were determined by reviewing footage. Behavioral responses varied among turtles, and we were broadly able to bin the turtles into two groups: those whose dives didn't get longer as their trial progressed, and those whose dives did get longer over time. Contrary to prior studies, we didn't observe long submersion times. Based on our observations, we hypothesize that the acclimation period required to observe submersion behavior comparable to behavior *in situ* is much longer than anticipated. We recommend future investigations experimentally determine the duration of acclimation required to observe this species' capacity for prolonged submersion.

#8 DIVING BEHAVIOR AND VOLUNTARY SUBMERSION TIMES OF A TROPICAL SEMIAQUATIC TURTLE IN BELIZE

Ellie DeCarlis. Ecology, Conservation, and Wildlife. Faculty Advisor: Day Ligon.

The Furrowed Wood Turtle (*Rhinoclemmys areolata*) is a semi-aquatic turtle that inhabits savannas and forest edges in Central America. Although primarily terrestrial, they have been observed foraging and copulating in water. The aim of my study was to assess how well adapted this semiaquatic species is to aquatic conditions. To measure this, 14 individuals were captured and placed in tubs of water for an uninterrupted 24-hour period. Following overnight acclimation, a time-lapse camera recorded the turtle's activity during the day for a 10-hour trial period. I then analyzed the photos and recorded time spent submerged versus at the surface. Results revealed variation in submersion behavior; only 5 turtles (36%) spent time submerged, while the remaining 9 (64%) remained positively buoyant throughout the trial. I found no significant difference between the dive durations of male and female turtles and no correlation between size and maximum dive duration. Counterintuitively, non-diving turtles had higher body density than divers did, suggesting that being dense does not determine tendency to dive. However, within the subset that dived, body density positively correlated with maximum dive duration. These results suggest that this species may have high capacity but low propensity for prolonged submersion.

#9 HYPORHEIC RESILIENCE: INVERTEBRATE COMMUNITIES MINIMALLY AFFECTED BY VARIABLE CHANNEL STABILITY ALONG A GRAVEL-BED RIVER

Connor Bruemmer, Korinna Brandt, Marc Owen. Ecology, Conservation, and Wildlife. Faculty Advisor: Debra S Finn.

The major ongoing effect of climate change in Ozark rivers is increasing frequency and magnitude of floods, driving increased streambed movement and bank erosion. The hyporheic zone is a unique physical habitat within the sediment below the stream bed. Little is known of how hyporheic invertebrates might respond to increasing habitat instability. Given previously observed patterns of alternating stable and unstable channels along the Gasconade River, we asked if invertebrate communities in hyporheic gravels varied between stable and unstable locations. We chose 3 sites along the Gasconade, each with paired stable and unstable reaches. We collected 4 hyporheic samples within each ~100-m reach from ~45 cm hyporheic depth at points of shallow water depth. Invertebrate communities were diverse, with 29 unique taxa overall (25 from stable and 22 from unstable reaches), with both benthic- and groundwater-associated taxa indicating a functional hyporheic zone. Unstable reaches tended to have greater invertebrate densities, but overall community structure varied just as much within individual reaches as among reaches, suggesting that broader-scale patterns of channel stability have not fundamentally affected hyporheic communities. These results imply resilience of hyporheic communities to the increasing movement of gravel beds associated with climate change.

#10 INFLUENCES OF FISH ON VARIOUS AQUATIC EMERGENT INSECT TAXA ADULT BODY SIZE IN TWO SMALL, NON-PERENNIAL STREAMS.

Lily A. Smith, Tanner L. Conwell, Connor Bruemmer. Ecology, Conservation, and Wildlife. Faculty Advisor: Debra S. Finn.

Emergent aquatic insects can be valuable subsidies to both aquatic and terrestrial food webs. Fish may influence these subsidies through non-consumptive effects, including increased insect development rate and smaller adult body size. We are assessing if several understudied taxa emerge at smaller size in the presence of fish in two small, but diverse, non-perennial Ozarks streams, one with fish and the other fishless. During the peak emergence season for both streams, we trapped emerging insects along ~100-meter reaches. We focused on three common taxa in both study streams, an ameleetid mayfly, a nemourid stonefly, and a chloroperlid stonefly. We measured mesonotum width for mayflies and head capsule width for stoneflies as proxies for body size. Our results indicate that the mayfly emerged at smaller sizes in the fish stream, reflecting previous findings for similar mayfly species. Interestingly, female nemourid stoneflies were larger in the fish stream, which may be a strategy to maximize fecundity in fish presence. Data processing for chloroperlids is still underway. Examining life history responses of unassessed emergent aquatic insects in fish presence is key to understanding top-down influences on secondary production and energy subsidies, particularly in non-perennial streams.

#11 HOW DOES URBANIZATION INFLUENCE ECOLOGICAL STREAM FUNCTIONALITY?

Brynn E. Kayhill, Lily A. Smith. Ecology, Conservation, and Wildlife. Faculty Advisor: Debra S. Finn

Our goal for this study was to assess the ecological systems and indications of environmental health upstream and downstream of an area of high urbanization before, during, and after a new construction project begins. We are using macroinvertebrates to evaluate trends in water quality in two stream reaches of different levels of urbanization in Springfield. We collected macroinvertebrates semi-quantitatively from three habitats (riffles, pools, and rootmats) and identified them to the highest possible taxonomic resolution. To assess the ecological effects of urbanization, we have collected biotic and abiotic data before and during the project. "Before" data indicated relatively good physical habitat structure, and in the fall, there was nearly triple the abundance of macroinvertebrates than in the spring, indicating a more stable environment to support macroinvertebrates. There was high taxa richness overall; although a third were Chironomidae, and Plecoptera were absent, indicating poor water quality. Chemical evaluation between upstream and downstream sites suggested some improvement of water quality with downstream distance. We will continue monitoring these sites after the construction project is complete to gather valuable information about its effects.

#12 BOBBING, BENDING, DIPPING, TILTING – WHAT ARE THESE BIRDS DOING AND WHY?

Dalton Brown. Ecology, Conservation, and Wildlife. Faculty Advisor: Nadjé Najjar

Many terrestrial bird species incorporate characteristic head or whole-body movements variously described as 'bobs'. While many species are well-known to 'teeter' or 'bend', with at least one family named for it (the 'dippers'), these behaviors are often treated as quirks of evolution and have not been formally or systematically described. It is currently unknown how widespread 'bobbing' behavior is in birds or what function it may serve. We used a recent phylogeny of the Certhioidea (dippers, wrens, and allies) to systematically characterize the prevalence and possible ecological correlates of bobbing behavior in Wrens (Troglodytidae) with Pagel's 1994 test of correlated (discrete) character evolution. We found that bobbing behavior is significantly correlated with petrophily ($P = 0.002$) and terrestriality ($P < 0.001$), but not propensity to walk vs hop ($P = 0.079$). These results suggest that bobbing does indeed have an as-of-yet unknown function and is not a quirk of evolution.

#13 TIME OF DAY DOES NOT AFFECT FEEDING LATENCY OR SWIMMING PERFORMANCE OF NORTHERN COTTONMOUTH SNAKES

Sam Walker-Schaefer and Olivia Hoffner. Ecology, Conservation, and Wildlife. Faculty advisor: Brian Greene.

Many animals exhibit distinct diel activity patterns that are often generalized as diurnal, nocturnal, or crepuscular, reflecting conditions under which hormonal and sensory systems are optimized. While some snake species display discrete diel patterns, others exhibit more labile activity schedules that allow both daytime and nighttime activity. We used a repeated measures design to evaluate the influence of time of day on behavioral (latency to feed) and physiological (swimming speed) traits in juvenile Northern Cottonmouths (*Agkistrodon piscivorus*), a species that appears to shift activity schedules seasonally. Mean latencies to emerge from shelter during feeding trials were statistically similar for daytime and nighttime trials for both summer and winter trials, indicating lack of a circadian pattern. In performance trials, temperature had a significant positive influence on swimming speed, but time of day had no discernible effect on snake performance at any temperature. Unlike some snake species that exhibit performance dichotomies that reflect their preferred activity period, our results suggest that *A. piscivorus* is a cathemeral species. Our results are consistent with the expectation of ambush foraging species exhibiting similar performance levels throughout the diel cycle to adaptively exploit contrasting activity schedules of diverse prey species.

#14 FLOWERING PLANT ENDEMICITY IN TALLGRASS PRAIRIES INCREASES BUMBLE BEE COMMUNITY HEALTH

Maev Winchester, Kendra N. Edge, Anthony M. T. Castagna, Charlotte C. Davis, Rita N. Afagwu, Leo P. Carpenter, Success C. Ekemezie, Jenny K. Burrow, James D. Bynum, Ashley N. White, Kierstin C. I. Howard, Tabitha Moul. Ecology, Conservation, and Wildlife. Faculty advisor: Avery L. Russell.

Plant invasions often negatively affect foraging by endemic animals. Although invasive plants may serve as novel foods, they may also reduce overall food quality if they replace more nutritional native food plants. Remnant tallgrass prairies are critical pollinator habitat but are also subject to plant invasions. Pollinators such as bumble bees are often closely associated with endemic plants thought to satisfy their nutritional needs, however, the influence of plant invasions on endemic bumble bee ecology is unknown. Here we examined how flowering plant invasions of remnant tallgrass prairies influenced bumble bee biodiversity and diet breadth. We predicted that with less endemicity, (1) bee diet breadth would increase to compensate for reduced nutritional quality of nonendemic pollen, and that (2) bee richness and abundance would decrease, as a result of poorer nutrition. We therefore surveyed flower and bumble bee richness and abundance across 12 tallgrass prairies in Southwest Missouri in 2023 and 2024 and removed pollen from bee pollen baskets to characterize host plants. Diet breadth specialization increased with increasing endemicity. Additionally, bumble bee abundance and richness increased as the number of endemic species and endemic flowers increased. Our results suggest that plant invasions may negatively impact bumble bee community health.

#15 BERRY IMPORTANT POLLINATORS: EVALUATING THE ROLE OF ARTHROPODS IN POLLINATION OF THE AMERICAN ELDERBERRY

Jenny K. Burrow, Katelin M. Meek, Anthony Moth T. Castagna, Oscar V. Peterson, Ashley N. White, Maev Winchester, Alaina K. Morrisey, James D. Bynum, Caleb S. O'Neal, Andrew L. Thomas. Ecology, Conservation, and Wildlife. Faculty advisor: Avery L. Russell.

The American elderberry (*Sambucus nigra* subsp. *Canadensis*), native to eastern North America, has historically served as a medicinal and food resource for many North American indigenous groups. In addition to a history of indigenous use of this plant species, in recent years there has been renewed interest in elderberry as a health supplement. Despite increasing interest in elderberry agriculture, its pollination ecology remains poorly understood. In this field study, we sought to characterize elderberry pollination ecology by assessing the identity and abundance of arthropod visitors, the relative importance of visitor taxa to pollen transport, and the effect of arthropod visitation on pollination (i.e. fruit set). Diverse arthropods visited elderberry flowers, with roughly 40% of them belonging to traditional pollinator taxa including Syrphidae, Geometridae, and Cantharidae. Pollen loads of flower visitors varied considerably, with loads of 0 to >221,000 pollen grains. Arthropod families with large elderberry pollen loads also generally had higher quality pollen loads (i.e. higher percentage of conspecific pollen). Arthropod visitation impacted pollination success, as excluding arthropod visitors reduced ripe fruit set, although this effect varied among cultivars. Altogether, our results suggest that arthropods play a significant role in the pollination ecology of the American elderberry.

#16 EFFECT OF TIRE WEAR PARTICLE 6PPD AND 6PPDq ON HepG2 LIVER CANCER CELL METABOLISM

Magdalena Singleton, Emma Braun, and Dr. Kyoungtae Kim. Cellular, Microbiology, and Genetics. Faculty Advisor: Kyoungtae Kim

In the United States alone it is estimated that 1.12 million tons/year of tire wear particles are produced when automobile tires come in contact with the road. Tire wear particles, 6PPD and its quinone version, 6PPDQ, have been tested in many *in vivo* studies, revealing impaired swimming capabilities in zebrafish, and accumulation in mouse livers. However, the precise toxic mechanism of 6PPD and 6PPDQ on a cellular level remains poorly understood, specifically how mitochondrial activities are affected in mammalian cells by them. To evaluate the impact of 6PPD and 6PPDQ on mitochondrial function, HepG2 cells were incubated with a range of 6PPD and 6PPDQ (12.5 μ M-200 μ M) via two fold serial dilution for 24 hours, followed by XTT cell viability assay, mitochondrial staining, and ATP quantification experiments. A dose-dependent reduction in cell viability, mitochondrial mean branch length, and ATP levels were observed after 6PPD treatment. 6PPDQ induced a slightly increased cell viability across all concentrations. Qualitative results suggest linear polymerization of 6PPDQ, and subsequently a reduced capacity to enter the cell, as rationale for these results. Ongoing studies, such as RNA sequencing, are being conducted to explore the transcriptome changes in HepG2 cell response to 6PPD to better understand the specific pathways that may lead to mitochondrial dysfunction after 6PPD treatment.

#17 DOXORUBICIN-LOADED CHITOSAN NANOPARTICLES: ENHANCING STABILITY AND TARGETED ANTICANCER ACTIVITY

Madi Frerichs, Abhishu Chand, Lana Jane Janson, Moupia Tajrin Oyshi, Mohammad Galib. Cellular, Microbiology, and Genetics. Faculty Advisor: Kyoungtae Kim and Robert Mayanovic

Nanotechnology allows transformative potential for targeted cancer diagnostics and therapeutics, by using chitosan-based nanoparticles (CSNPs) which serves as a biocompatible and biodegradable vehicle. There are limits to using CSNPs due to their restricted ability of low/poor stability, solubility, and premature drug leakage. Knowing this, the study's focus is to address these challenges by developing doxorubicin-loaded CSNPs (Dox-CSNPs) and comparing the efficacy with electrostatic versus covalent conjugation, doing so by targeting folate receptors in HeLa and Hep-G2 cancer cell lines. We were able to synthesize DOX-CSNPs which were then characterized using X-ray diffraction (XRD) and dynamic light scattering (DLS), revealing the average particle size of 18-23 nm. XRD analysis confirmed a semi-crystallinity, while zeta potential measurements of PVA-loaded variants which are indicated by a negative surface charge of -49 mV. Preliminary cytotoxic assays demonstrated that DOX-CSNPs exhibit superior anticancer activity compared to free DOX across both cell lines. We are continuing to research focus on enhancing drug specificity through folic acid modification and evaluating drug release kinetics using the dialysis bag method. By optimizing covalent conjugation and pH-responsive release, this study focuses the potential of modified CSNPs as a highly effective delivery system for advanced cancer treatment.

#18 A COMPREHENSIVE STUDY OF QUANTUM DOTS INTERACTIONS WITH ACTIN AND AN ACTIN BINDING PROTEIN

Elijah Billue, Abhishu Chand, Nhi Le, Tony Astuhuman. Cellular, Microbiology, and Genetics. Faculty Advisors: Kyoungtae Kim and Ridwan Sakidja.

Quantum dots (QDs) are nanoparticles with unique optical and fluorescent properties, making them a promising medical tool for bioimaging and drug delivery. However, their biological integration has been hindered by QDs' ability to non-specifically interact with intracellular proteins. This study investigates QDs' interactions with actin and α -actinin through biochemical and computational approaches. Spin-down assays were used to examine the effects of QDs on actin bundling in the presence of α -actinin. Fluorometric assays allowed for the comparison of the depolymerization rates of the actin and α -actinin structure versus actin alone in the presence of QDs. We used GROMACS to model and Chimera X to visualize QDs binding on different electrostatic surfaces of α -actinin. The data indicates actin bundling in the presence of α -actinin is hindered by increasing concentrations of QDs. However, in contrast to actin alone, the initial depolymerization rate of the actin and α -actinin complex did not increase dramatically with high QD concentrations. The quenching of α -actinin with QDs quantified the binding affinity while the computer simulation demonstrated how QDs were binding to α -actinin. In summary, through providing insight on how QDs disrupt cytoskeletal integrity, we hope QDs can be utilized in a way that minimizes toxic effects.

#19 DETECTION OF TETRACYCLINE RESISTANT BACTERIA IN SOIL SAMPLES

Erin Hachez, Colbie Allison. Cellular, Microbiology, and Genetics. Faculty Advisor: Will Sewell.

Antibiotic resistance is emerging as a global healthcare crisis. If an effective solution is not found and produced in a timely manner it will have a detrimental impact on how society is able to treat bacterial infections. This may cause even more trouble than before the discovery of antibiotics. The objective of this research is to identify the specific gene causing antibiotic resistance in bacteria that was found in a local soil sample. The soil sample in early testing has proven to show some resistance to Tetracycline through extended growth on plates prepared with Tetracycline 3 and Tetracycline 30. To accomplish this, two different methods were used, candidate gene approach and whole genome surveillance. With candidate gene approach, there were six different primer sets used that signal the presence of Tetracycline resistant genes. Nanopore sequencing was implemented for genomic monitoring. Early examination of testing approaches has confirmed some presence of Tetracycline AC and Tetracycline G. Additional testing also yielded negative results for RPP primers, with no positive control available.

#20 GREEN ALTERNATIVE SYNTHESIS OF EDARAVONE THROUGH A SULFITE/BISULFITE SYSTEM

Chadd Huffman. Cellular, Microbiology, and Genetics. Faculty Advisor: Patrick Casey

Edaravone is a clinically significant antioxidant and neuroprotective compound used in the treatment of ALS and stroke to minimize oxidative stress damage. Traditional synthesis from aniline relies on hazardous reducing agents, large reagent excess, and non-sustainable conditions. In this work, a greener method was developed using safer reagents and aqueous conditions. phenylhydrazine HCl was synthesized from aniline via diazotization followed by reduction with a sulfite/bisulfite system, avoiding the formation of toxic tin waste. The process was conducted under mild, energy-conscious conditions. An intermediate then forms that is hydrolyzed by the acidic conditions into phenylhydrazine HCl. Phenylhydrazine HCl was then reacted with ethyl acetoacetate at pH 6 to form Edaravone in aqueous solution via in-situ freebase formation and rapid phenylhydrazone formation. Sodium hydrosulfite was used to suppress oxidation of reactants, intermediates, and product. This work demonstrates a practical, greener route to Edaravone and highlights the importance of reaction optimization and minimizing environmental impact.

#21 CHARACTERIZATION OF TRIGEMINAL GANGLION ORGANOID CULTURES

Amelia Easterling, Ania Kovacs, Nicole Nalley. Cellular, Microbiology, and Genetics. Faculty Advisor: Paul Durham.

The use of organoid cultures offers advantages by mimicking complex cellular interactions and allowing the study of disease progression. Calcitonin gene-related peptide (CGRP) and enhanced trigeminal ganglion (TG) neuron-glia cell communication are implicated in TMD and migraine pathology. Our aim was to characterize temporal changes in cellular morphology, protein expression, and cellular function in TG organoids. Day 3-5 neonatal Sprague-Dawley rat pups were used to establish primary organoid cultures of TG. Changes in protein expression and intracellular calcium levels were investigated using fluorescent microscopy at weeks 1, 2, 3, and 4. The cellular architecture changed with time with satellite glial cells associating with the neuronal cell body to form functional units while Schwann cells aligned with neuronal processes to form fiber tracks. Neuronal expression of CGRP was observed at all times. Temporal differences in the amplitude and duration of KCl-mediated changes in intracellular calcium were observed in A δ and C-fiber neurons, satellite glia, and Schwann cells. Our culture conditions facilitate development of organoid cultures with similar morphology, protein expression, and cell function as in vivo TG. In future studies, TG organoids will be utilized to investigate cellular changes caused by inflammatory conditions and in response to pharmacological and nutraceutical agents.

#22 CALCITONIN GENE-RELATED PEPTIDE AND GRAPE SEED EXTRACT DIFFERENTIALLY MODULATE EXPRESSION OF PROTEINS IN TRIGEMINAL GANGLION NEURONS AND GLIA

Ania Kovacs, Nicole Nalley, Amelia Easterling. Cellular, Microbiology, and Genetics. Faculty Advisor: Paul Durham.

Sensitization of trigeminal ganglion neurons and glia is implicated in migraine and TMD pathology. We hypothesized that calcitonin gene-related peptide (CGRP) would promote sensitization, while the nutraceutical grape seed extract (GSE) would suppress sensitization. Protein expression in response to CGRP and GSE in primary trigeminal ganglion cultures from neonatal Sprague Dawley rats were investigated by immunocytochemistry. Two-hour CGRP incubation significantly increased P-p38 and GAD67 levels in A δ neurons, P-p38, iNOS and GAD67 in C-fiber neurons and GABAB1 in Schwann cells. Overnight CGRP incubation decreased GABAB1 in A δ neurons, increased P-p38 and PKA while decreasing GABAB1 in satellite glia, and stimulated expression of RAMP1, PKA, GAD65, and GAD67 while suppressing GABAB1 in Schwann cells. Overnight GSE incubation caused a decrease in RAMP1 expression in neurons, suppressed iNOS in satellite glia and Schwann cells, stimulated GAD65 in C-fiber neurons and satellite glia, and enhanced GABAB1 in satellite glia and Schwann cells. Coincubation of GSE with saclofen, a GABAB1 antagonist, suppressed the inhibitory effect of GSE on RAMP1 and iNOS, and the stimulation of GAD65 but did not inhibit GSE's stimulatory effect on GABAB1 expression. Our results support the potential benefit of GSE as a nutraceutical dietary supplement for migraine and TMD.

#23 TRANSIENT TEMPOROMANDIBULAR JOINT HYPEREXTENSION IS ASSOCIATED WITH ALTERED FEEDING BEHAVIORS: SUPPRESSION BY GRAPE SEED EXTRACT

Colleen Myers, Mikayla Scharnhorst, Donovan Aardema Faigh. Cellular, Microbiology, and Genetics. Faculty Advisor: Paul Durham.

Temporomandibular joint (TMJ) pathology is associated with altered feeding behaviors to minimize pain and discomfort. Increased nociception and altered gene expression in female, but not male rats, was observed in our preclinical TMJ injury model caused by TMJ hyperextension, which can occur during yawning or a dental procedure. Changes in feeding behaviors were evaluated to determine if dietary supplementation with a grape seed extract (GSE) could suppress behavioral changes caused by TMJ hyperextension. At multiple times post-TMJ hyperextension, changes in behaviors associated with feeding were assessed in young Sprague Dawley female rats. Behaviors associated with feeding including the amount of food consumed, rate of eating, grooming, escapism, searching for food, hoarding, and hyperactivity levels were investigated. Animals subjected to TMJ hyperextension had higher scores on days 1 and 6 compared to naive animals and those animals supplemented with GSE. Animals receiving GSE as a dietary supplement had a lower total score on days 1, 6 and 13, being comparable to naive levels. Our findings provide evidence that TMJ hyperextension is associated with changes in feeding behaviors that correlate with enhanced nociception. Further, our results demonstrated that the changes in feeding behavior were suppressed by inclusion of the dietary nutraceutical GSE.

#24 TRANSIENT HYPEREXTENSION OF THE TEMPOROMANDIBULAR JOINT IS ASSOCIATED WITH CHANGES IN GABAERGIC PROTEINS IN THE SPINAL TRIGEMINAL NUCLEUS: SUPPRESSION BY DIETARY SUPPLEMENTATION WITH GRAPE SEED EXTRACT

Monique Fiagan, Colleen Myers, Mikayla Scharnhorst, Donovan Aardema Faigh. Cellular, Microbiology, and Genetics. Faculty Advisor: Paul Durham.

Temporomandibular disorder (TMD) is the most prevalent orofacial pain condition, with greater prevalence in females, and is associated with pain in the temporomandibular joint (TMJ) and muscles of mastication. Results from our lab show that dietary supplementation of a proanthocyanidin-enriched grape seed extract (GSE) could inhibit pain signaling in a preclinical TMD model. The goal of this study was to determine if GSE could suppress changes in proteins implicated in pain signaling caused by TMJ hyperextension. Changes in protein expression were investigated by immunohistochemistry in the spinal trigeminal nucleus (STN) from adult female Sprague Dawley rats 14 days post TMJ hyperextension. Some animals received GSE as a dietary supplement for one week prior to TMJ hyperextension and throughout the study. The expression of GAD65 and GABA receptors was elevated when compared to levels in naive animals. Inclusion of GSE in the diet suppressed the stimulatory effects on the GABAergic pathway proteins to levels more similar to naive animals. Findings from this study provide evidence that female animals enhance the expression of GABAergic proteins known to suppress inflammation and pain signaling and supplementation of the nutraceutical GSE prior to TMJ hyperextension suppresses those changes to help maintain homeostasis in the STN.

#25 REDUCING SOLVENT CONSUMPTION BY IN SITU FMOC REMOVAL SOLID-PHASE PEPTIDE SYNTHESIS WITH HIGHLY REACTIVE COUPLING AGENTS

Khang Bui. Chemistry and Biochemistry. Faculty Advisor: Keiichi Yoshimatsu

Solid-phase peptide synthesis (SPPS) is a widely used method for the preparation of peptides, with Fmoc deprotection typically requiring separate reaction and washing steps. In this study, we investigated in situ Fmoc removal as a strategy to streamline peptide synthesis, reduce processing time and reduce solvent consumption. As a model peptide, Gly-Phe-Leu (GFL) was synthesized on a Rink Amide AM resin at a 0.1 mmol scale using both conventional SPPS and an in situ deprotection approach. Coupling of Fmoc-amino acid was carried out using HBTU/HOBt/DIPEA-mediated coupling, followed by cleavage with trifluoroacetic acid and lyophilization. Both synthesis strategies successfully yielded the target peptide, with comparable yields observed for the standard SPPS method (75.99–87.99%) and the in situ method using 20% 4-MP (77.26–81.84%). Overall, the in situ Fmoc removal protocol reduced the number of steps and the amount of wasted solvent and increased the efficiency of the workflow without compromising yield significantly. These results indicate that In Situ Fmoc removal protocol was compatible with HBTU/HOBt/DIPEA. The next step of this study is to analyze the purity of the peptides by HPLC and LC-MS.

#26 A PATHWAY TOWARDS UNDERSTANDING THE ORIGINS OF LIFE: INVESTIGATING L-AMINO ACID DOMINANCE IN BIOLOGICAL SYSTEMS

Kyle Ramaker. Chemistry and Biochemistry. Faculty Advisor: Keiichi Yoshimatsu

Through the process of evolution, biological systems selected to predominantly use *L*-amino acids rather than their mirror-image counterparts, *D*-amino acids. The selection of *L*-amino acids over *D*-amino acids presumably occurred on prebiotic Earth, while there is no consensus on how the *L*-form propagated over the *D*-form. One hypothesis to address this question is that nature segregated *L*- and *D*-amino acids from *D/L* mixtures by selective self-assembly, leading to the evolution of a system that predominantly uses one enantiomer. In this work, we aim to study amino acid conjugated-dynamic combinatorial libraries (DCLs), which undergo constant exchange of covalent bonds and form a “library” of products. To pursue this goal, I performed a multi-step synthesis to form 3,5-bis(tritylthio)benzoic acid, with each intermediate undergoing characterization using IR spectroscopy, ¹H-NMR, ¹³C-NMR, and ESI-MS. In the next step, solid-phase peptide synthesis will be employed to couple amino acids to 3,5-bis(tritylthio)benzoic acid. Upon completion of the synthesis, DCLs will be prepared and continuously monitored using LC-MS. We envision that this work will provide insights into a plausible path that led to the segregation (and eventual propagation) of *L*-amino acids, thereby helping to unravel one of life’s greatest mysteries.

#27 SYNTHESIS AND CHARACTERIZATION OF PT-CYCLOHEXYLAMIDE CYANOXIMATES

C. Mitch Lindner. Chemistry and Biochemistry. Faculty Advisor: Nikolay Gerasimchuk.

The concept of using heat damage to target tumors or Photothermal Cancer Therapy (PTT) has been around for a while in the scientific community with the delivery of PTT compounds being one of the key important aspects of that method. In this method, we see a few issues; Heavy metal poisoning, difficult solvable of compounds for drug preparation, and interaction *in vivo*. To contest these issues, we created two new cyanoximes with non-polar cyclohexane to help with depolarization once anionic in their respective platinum complexes. Known as Pt(CACO)₂ and Pt(d-CACO)₂, which are platinum monosubstituted or disubstituted cyclohexylamide cyanoximates. We performed multiply forms of characterization on the platinum complexes to which we believe are sufficient to move onto their photothermal testing. Their characteristic similarities to priorly studied cyanoximes that have amide groups give us reason to believe that they will also be cytotoxic.

#28 INVESTIGATING HEMAGGLUTININ-MEDIATED INFLUENZA BINDING AND FUSION USING MAGNETIC LIPOSOME NANOSENSORS

Emilee Dees, Justin Reiner, Jacklyn White. Chemistry and Biochemistry. Faculty Advisors: Tuhina Banerjee and Santimukul Santra*

Influenza remains a major global public health threat, causing millions of illnesses and hundreds of thousands of deaths annually. Viral entry into host cells is mediated by the surface glycoprotein hemagglutinin (HA), which binds to sialic acid residues on host membranes. This study uses liposome-coated iron oxide nanosensors (LIONS) to mimic host cell membranes and quantitatively measure influenza binding to the membrane and fusion in real time. Membrane binding and fusion are detected through changes in T2 relaxation caused by alterations in water protons near the nanoparticle surface and the results are validated using calcein-liposome fluorescence assays. The gangliosides GM1, GD1a, and GD1b are incorporated into the lipid bilayer to evaluate how differences in the number and arrangement of sialic acid residues affect the interactions driven by hemagglutinin. These findings provide insight into how host membrane composition can influence influenza binding and fusion.

#29 KINETIC ANALYSIS AND STRUCTURAL CHARACTERIZATION OF CERIUM OXIDE NANOPARTICLES

Amoakoa Owusu Yeboah. Chemistry and Biochemistry. Faculty Advisor: Tuhina Banerjee.

Nanoceria (cerium oxide nanoparticles) has gained significant attention due to its unique redox properties and wide applications in catalysis, biomedicine, and environmental remediation. This study investigates the structural and kinetic characteristics of synthesized nanoceria using multiple analytical techniques. The nanoparticles were prepared via an ammonia-assisted co-precipitation and characterized through Fourier-transform infrared spectroscopy (FTIR), UV-Vis spectroscopy and Dynamic Light Scattering (DLS) measurements. Results indicate that the synthesized nanoceria exhibits consistent substrate affinity and stable kinetic qualities. DLS analysis confirms moderately uniform particle distribution and Zeta Potential, while FTIR spectra reveals the presence of functional groups associated with polyacrylic acid (PAA) that represent chemical interaction and UV-Vis spectroscopy monitors the reaction kinetics and catalytic activity of nanoceria. These findings demonstrate that the synthesized nanoceria possesses stable properties suitable for catalytic and biomedical applications, highlighting its potential for bacterial detection.

#30 CHARACTERIZATION OF BERGAMOT EXTRACTS AND THEIR INHIBITORY EFFECTS ON HMG-CoA REDUCTASE

Alaina Worland. Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore.

Citrus bergamia (bergamot), a citrus fruit widely recognized for its use in health supplements and Earl Grey tea, has recently attracted scientific interest for its effects on cholesterol levels. This study aimed to identify which out of five bergamot flavanoids (neoeriocitrin, naringin, neohesperidin, melitidin, and brutieridin) interact with and inhibit the 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMG-CoA reductase) enzyme. HMG-CoA plays a key role in the synthesis of cholesterol, and is the target of statins, the class of medication that is prescribed to lower cholesterol levels. The enzyme was successfully purified via nickel-affinity chromatography, and purity was confirmed with an SDS-PAGE gel. The five bergamot compounds and several dietary bergamot supplements were separated and characterized with high-performance liquid chromatography (HPLC), which was followed by liquid chromatography-mass spectroscopy (LC-MS) to analyze and verify the compounds. UV-visible spectrophotometry was used to observe changes in absorbance over time to measure the enzymatic activity of HMG-CoA reductase and the effectiveness of each potential inhibitor. These results suggest that melitidin is the strongest inhibitor of HMG-CoA reductase.

#31 THERMOSTABLE GREEN PROTEIN E144H MUTATION'S IMPROVEMENT OF COPPER AFFINITY.

Madison Guetzkow and Morgan Brill. Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore.

Thermal green protein (TGP-E) is a fluorescent protein known for its increased thermal stability and bright green hue. Fluorescent proteins are tagging tools widely used in molecular biology. Their unique fluorescence and ability to be encoded onto other proteins at the genetic level allow them to be used to investigate specific intracellular structures or organelles. An E144H mutation was introduced with site-directed mutagenesis performed through PCR and subsequently transformed into XL10-Gold Ultracompetent cells. The mutation was verified by DNA sequencing. A transformation of the plasmid into BL21(DE3) cells was performed in LB media with added IPTG to induce protein production. Cells were then centrifuged and resuspended in buffer for harvesting; preceding being lysed via sonication. After removing any insoluble debris through centrifugation, TGP-E E144H was purified using a nickel affinity column with NiNTA buffers. Several microplates were utilized to show fluorescence of TGP-E E144H those being varying concentrations of copper and zinc, varying pH levels, and varying molarities of Guanidium. The microplate reader showed a correlating relationship in the decrease in pH and Guanidium molarity and the fluorescence of TGP-E E144H and an increase in the affinity for copper binding in TGP-E E144H compared to TGP-E.

#32 STRUCTURAL INVESTIGATION OF COPPER BINDING SITES IN A THERMOSTABLE GREEN FLOURESCENT PROTEIN

Morgan Brill and Madison Guetzkow. Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore.

The thermostable green fluorescent protein (TGP-E) has previously shown correlations with copper in multi-metal fluorescence assays, suggesting a potential copper binding interaction that may alter protein structure. This study aims to characterize the mechanism of copper binding by examining two histidine-containing residues proposed to coordinate copper. Site-directed mutagenesis was used to generate two variants designed to modify potential binding sites: R198H, which introduces an additional histidine residue, and H216S, which removes a histidine residue from a second proposed binding site. These variants are to be analyzed through crystallization in the presence of copper to enable structural determination by X-ray crystallography. However, since copper binding may promote partial protein unfolding and hinder crystal formation, seeded crystallization using TGP-E crystals is being explored to facilitate crystal growth under copper containing conditions. Determining the structural basis of copper interaction with TGP-E will provide insight into how metal ions influence the stability and fluorescent behavior of thermostable fluorescent proteins.

#33 EFFECTS OF P145 DELETION ON THERMOSTABLE GREEN PROTEIN ANALOG PERFORMANCE.

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

This study examined the effect of the deletion of proline residue 145 on TGP Q66E on excitation and emission wavelength, thermal and pH stability, quantum yield, structural prediction and optimization of the crystallography. Deletion of residue 145 from TGP Q66E was predicted by AlphaFold3 to result in an uninterrupted beta strand seven in the structure of TGP Q66E. In cyan versions of GFP, removing the gap in beta strand seven resulted in a substantial improvement in fluorescent brightness. We hypothesized that this adjustment may have similar results with the TGP derived proteins. Thermal stability, and pH stability were measured using Spectramax M5 after 1 hour, and crystallography was optimized using hanging drop vapor diffusion. The proline deletion displayed a significant decrease in quantum yield compared to TGP Q66E, thermal and pH stability remained similar, the excitation wavelength changed from 493nm to 474nm. Structural analysis showed incomplete connection of beta sheet, and decreased hydrogen bonding of the chromophore, however further refinement is needed to improve quality metrics.

#34 SCALABLE POLYNOMIAL INTERPOLATION VIA MAPREDUCE AND A NEW RECURRENCE-BASED QUOTIENT-RING INTERPOLANT

Christopher Housholder. Computer Science. Faculty Advisor: Hazhar Rahmani

Classical polynomial interpolation methods scale poorly on large datasets, exhibiting quadratic complexity and degraded numerical stability, while piecewise approaches trade global accuracy for efficiency. In this work, we present a systematic benchmarking study of eleven classical interpolation algorithms implemented in MapReduce, showing that few remain computationally feasible beyond 10^5 nodes and none simultaneously achieve high accuracy, parallel efficiency, and stable extrapolation. We also introduce a recurrence-based interpolation method formulated in a quotient ring via its characteristic polynomial. The resulting interpolant retains global polynomial behavior while achieving near-linear MapReduce complexity. Empirically, it matches classical polynomial accuracy, runs at piecewise speed, and exhibits markedly improved extrapolation stability. These results position recurrence-based quotient-ring interpolation as a scalable alternative to classical polynomial methods in large-scale environments.

#35 DISCRETE INDUCTIVE WIRELESS POWER TRANSFER FOR LOW-POWER DEVICES

Kristin Burdine, Elijah Totten, and Jonathan Ross. Cooperative Engineering. Faculty Advisor: Theresa Odun-Ayo

This project aims to investigate a discrete component inductive wireless power transfer system to better understand power electronics typically enclosed in complex integrated circuits. This system uses observable analog topologies enabling direct analysis of system behavior. The system consists of a transmitter and receiver, where input power is converted from AC to DC, inverted to high-frequency AC for wireless transmission, and rectified back to DC at the load. The transmitter includes a series of operational amplifier topologies to implement pulse width modulation with closed-loop feedback to regulate output voltage under varying load conditions. This signal drives a half-bridge MOSFET inverter to excite a resonant LC tank and the transmitter coil. The receiver converts the induced AC signal into regulated DC power to operate a fan without physical connections. A foreign object detection circuit uses current monitoring to detect abnormal conditions and shut down the system. An Arduino measures current through a low-side shunt resistor and displays real-time power transfer. The system achieved up to 7 W output with 70–80% power efficiency at 2 mm coil separation.

#36 GREEN ENERGY HARVESTING THROUGH SMALL-SCALE GENERATORS FOR PERSONAL USE

Austin Miller, Cody Busch, Parker Smith. Cooperative Engineering. Faculty Advisor: Theresa Odun-Ayo

Power can be generated using many different forms of green energy sources. Among these potential sources are gravitational potential energy in the form of a water wheel, mechanical potential energy in the form of a manual crank and wind turbine, and potential energy utilizing the photoelectric effect in the form of solar panels. The M.E.H. (Modular Energy Harvester) is a mobile, compact version of the larger green energy generators found in the field to be used in charging and powering small devices like laptops and phones. It generates AC power (wind, water, hand crank) and DC power (solar), rectifies the AC into DC power, stores the generated power in a battery bank, and inverts the stored DC into useable AC power at 120V/60Hz. The M.E.H.'s modular design allows for substitution of generators to optimize power generation based on availability of green energy. Displays are present at each junction of power transfer to accurately see the contributions of each generator, in addition to the total charge stored within the battery bank.

#37 HOMEEDEN SPROUT: ITERATIVE DESIGN OF AN AUTOMATED HOUSEPLANT WATERING SYSTEM

Tyler Mills, Brandon Butler. Cooperative Engineering. Faculty Advisor: Dr. Theresa Odun-Ayo.

This presentation outlines the engineering design process behind the HomeEden Sprout, a standalone houseplant watering device. We detail the iterative prototyping phases, culminating in a second-stage "works-as" prototype utilizing an ESP32 microcontroller. The methodology focuses on control logic to prevent overwatering, using a capacitive soil moisture sensor to inform the operation of a peristaltic pump, while an addressable LED provides immediate, color-coded feedback for moisture levels and error states. The current iteration evaluates a low-cost structural design employing dual perfboards secured with plastic yarning canvas mesh and zip ties. Furthermore, we analyze the development of a local web interface that prioritizes a minimalist, utilitarian, yet intuitive user experience for tracking historical data and providing manual controls. By examining the design, implementation, and testing of these components, this poster evaluates the Sprout's viability for maintaining optimal plant health. Finally, we discuss data gathered to establish requirements for future iterations, including custom printed circuit boards, dedicated enclosures, and broader internet connectivity.

#38 POLLUTION PREVENTION IN MISSOURI INDUSTRY: AN EPA-FUNDED INITIATIVE

Rebecca Grant. Cooperative Engineering. Advisors: Sanjay Tewari and Doug Neidigh

Increasing energy costs, both economically and regarding public health and welfare, continue to be cause for global concern. P2: The Pollution Prevention Project, is funded by the United States Environmental Protection Agency. The project aims to assist manufacturers in eliminating pollution at the front-end of production. This poster presents the auditing process used and preliminary schema of assessing pollution prevention strategies for an unnamed Missouri manufacturer, focusing on the usage of water, energy, and solid waste generation. The primary objective is the reduction of waste in the company's processes and operations, achieving positive ROI. Multiple on-site assessments are being conducted, and targeted implementation of reductions of waste will be suggested. This will save the industry money that would otherwise be wasted, while simultaneously preventing emissions, solid waste, and unnecessary over-consumption. Missouri manufacturers are directed toward improvement opportunities, clearly presented with up-front costs and long-term savings, and specific strategies for execution.

#39 SPATIAL-TEMPORAL NONLOCAL TRAFFIC DYNAMICS: ANALYTICAL PROPERTIES, ADAPTIVE KERNEL FORMULATION, AND EMPIRICAL VALIDATION

Christopher Housholder. Mathematics. Faculty Advisor: Animesh Biswas

This paper presents a new macroscopic traffic flow model formulated through a nonlocal time-dependent framework designed to overcome the boundedness limitations inherent in classical local models. The proposed formulation incorporates both spatial and temporal nonlocality, allowing the velocity at a given point to depend on aggregated downstream traffic conditions over a finite time horizon. This structure provides a more realistic representation of driver anticipation and reaction behavior. To assess the practical relevance of the model, we perform a detailed validation using high-resolution NGSIM trajectory data. The results demonstrate that the nonlocal time-dependent model significantly improves the reconstruction of traffic density fields when compared with traditional local macroscopic models, particularly in regimes where driver anticipation plays a dominant role. These findings highlight the potential of nonlocal formulations as a robust framework for capturing complex traffic dynamics and improving data-driven traffic state estimation.

#40 THE ROOTS OF DISAGREEMENT

Christopher Housholder. Mathematics. Faculty Advisor: Steven Senger

We study functions $f : \mathbb{F}_p^d \rightarrow \mathbb{F}_p$ through their Fourier coefficients and associated root-of-unity structure. In particular, we examine how the bent condition, which requires all Fourier coefficients to have magnitude $p^{-(d/2)}$, restricts the behavior of such functions. Our main result shows that two bent functions cannot differ at exactly one point. The argument is elementary and proceeds by expressing Fourier coefficients in terms of multiplicities and analyzing the resulting constraints via roots of unity. This reduces the problem to a geometric condition in the complex plane, which leads to a contradiction. More generally, our approach illustrates how local changes in a function impose global restrictions on its Fourier structure.

#41 ESTIMATING WATER LOSS AND CLIMATE OUTCOMES FROM HABITABLE ZONE SUPER-EARTHS INFORMED BY PLANET FORMATION SIMULATIONS

Emmalein Pendley. Physics, Astronomy and Material Science. Faculty Advisor: Sarah Morrison

Super-Earths are some of the most common types of rocky exoplanets in our galaxy. In this study, we examine the effect of XUV radiation on the atmospheres of habitable zone (HZ) rocky planets, including Super-Earths and slightly smaller planets, and the possible implications of the resulting surface conditions. We have simulated the formation of a population of close-in rocky planets from protoplanetary discs, comparable to the observed populations. We then assessed which of these formed planets reside in the HZ. Then, we investigated the effects of XUV radiation on the upper atmospheres of these HZ planets and the resulting photolysis of water vapor into oxygen and hydrogen gas. This same process is believed to have caused Venus to lose its surface water early in its history. The loss of oceans on these planets would make them unlikely to be habitable in the long term. The goals of this project are to identify possible correlations between water loss from the surfaces of these planets and their physical parameters, and to investigate the overall habitability of rocky exoplanets orbiting near the inner edge of the habitable zone.

#42 ENCELADUS' EJECTED REGOLITH DISTRIBUTION

Mikayla Schuneman. Physics, Astronomy and Material Science. Faculty Advisor: Sarah J. Morrison

Enceladus is the main contributor of Saturn's E ring. The Cassini mission has helped provide clarity to some of the unknown origins and processes of this icy moon. A combination of tectonic activity and a subsurface liquid ocean allow for cryovolcanism to create the diffusive ring. The E ring being regenerative and made of ice water has also been paralleled with the regenerative surface of Enceladus—and later the discovered active geysers. The purpose of our research is to look at the regolith distribution of material escaping from Enceladus to figure out how it transfers to other Saturnian satellites. This requires looking and comparing both impact ejecta and geyser regolith ejecta. In addition, accounting for plasma drag in our simulations. The semi major axes of other Saturnian satellites may also affect the distribution of ejecta. We look at our previous simulations to determine whether median radii and triaxial ellipsoid shapes of other moons of Saturn produce different results of regolith distribution.

#43 SNOWLINE GIANT PLANET PERTURBATIONS AND HABITABLE ZONE PLANET STABILITY

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

Massive planets forming near the water ice snowline can significantly influence the orbits of Earth-mass planets in the habitable zone (HZ). This study uses N-body simulations to examine orbital perturbations in planetary systems around G-type and M-type stars. The configurations include a Jupiter-mass planet at the snowline of a G-type star and a Neptune-mass planet at the snowline of an M-type star, with Earth-mass planets positioned at various locations within the HZ. The analysis focuses on variations in semi-major axis, eccentricity, and the timescales of these changes. Results show that perturbations are stronger around M-type stars due to the snowline's proximity to the HZ, leading to higher eccentricity and more significant shifts in orbital distance. These changes directly affect the time-averaged stellar flux received, causing climatic instability.

#44 GRAVITATIONAL WAVE CLASSIFICATION WITH QUANTUM KERNEL SVMS FOR MULTI-MESSENGER ASTRONOMY

Bishwash Devkota. Physics, Astronomy, and Material Sciences. Faculty Advisor: Ridwan Sakidja.

The LIGO-Virgo-KAGRA network detects gravitational wave events in near real-time, requiring fast and accurate classification to trigger electromagnetic follow-up observations before the source fades. Candidates must be identified across five classes including binary black hole, binary neutron star, neutron star black hole, burst, and noise glitch, where delays or errors directly affect multi-messenger science. We apply a Quantum Kernel Support Vector Machine (QK-SVM) to this problem, encoding eight gravitational wave signal features into a high-dimensional quantum feature space using an eight-qubit circuit. Benchmarking against Random Forest and RBF-SVM shows that the quantum kernel achieves competitive classification accuracy while capturing feature correlations that classical methods miss. As next-generation detectors like the Einstein Telescope and Cosmic Explorer push event rates from hundreds to hundreds of thousands per year, scalable quantum classification methods will become increasingly important.

#45 QUANTUM REINFORCEMENT LEARNING FOR PORTFOLIO OPTIMIZATION

Asher Van Maanen. Physics, Astronomy and Materials Science. Faculty Advisor: Ridwan Sakidja

This project takes a quantum learning method originally used for choosing chemical materials and applies it to picking stocks. Both tasks are similar because they involve choosing the best options from a list to get the highest reward over time. By swapping chemicals for eight stocks and using a score for risk and return as the reward, the same quantum setup works for finance with very few changes. The study tested five different rules for when the system should restart its search, which is like an investor deciding when to update their portfolio. The results showed that restarting too often makes the system unstable, while keeping too much old information causes it to hesitate. One specific rule worked best by reaching a steady and clear balance of stocks. These findings show that quantum methods are flexible and can be successfully applied to a wide range of different applications.

#46 QUANTUM REINFORCEMENT LEARNING FOR ROUTE OPTIMIZATION: ADAPTING A CATALYST SELECTION FRAMEWORK TO THE TRAVELLING SALESMAN PROBLEM

Henry Hare. Physics, Astronomy, and Material Science. Faculty Advisor: Ridwan Sakidja.

This project adapts a quantum learning method originally used for catalyst material selection and applies it to a classic puzzle called the Traveling Salesman Problem, which seeks the shortest route between several cities. By swapping catalysts for cities and using the total travel distance as the reward, the same quantum setup can learn to find more efficient routes with very few changes. The study tested five different rules for when the system should restart its search to see which one helped the quantum agent find the best path. This project is important because the number of routes grows exponentially as the number of cities increases, which regular computers cannot keep up with. Because a quantum computer uses superposition to look at many paths at once, it becomes much more powerful than traditional computers as the problem gets more complex. These findings show that quantum methods are flexible and offer a major advantage for solving difficult logistical problems.

#47 QUANTUM KERNEL SUPPORT VECTOR MACHINES FOR MULTI-CLASS TRANSIENT CLASSIFICATION

Armitha Dutta. Physics, Astronomy, and Materials Science. Faculty Advisor: Ridwan Sakidja.

The Vera C. Rubin Observatory's Legacy Survey of Space and Time will generate 10 million alerts nightly, necessitating advanced computational frameworks for the real-time classification of transient phenomena such as supernovae and active galactic nuclei. In this study, we evaluate the performance of Quantum Kernel Support Vector Machines (QK-SVM) in categorizing five source classes using eight photometric and temporal features. By encoding these features into a high-dimensional Hilbert space via an eight-qubit quantum circuit utilizing both nearest neighbor and long-range entanglement, the model extracts complex patterns from the light curve data. Benchmarking results indicate that the quantum kernel achieves competitive accuracy compared to established random forest and RBF-SVM classifiers. These findings demonstrate that quantum-enhanced feature mapping is a viable and scalable methodology for processing the high cadence data streams produced by modern wide field astronomical surveys.

#48 PROBING THE NANO-BIO INTERFACE: STUDYING THE INTERACTIONS BETWEEN NANOPARTICLES AND BIOMOLECULES

Armitha Dutta. Physics, Astronomy, and Materials Science. Faculty Advisor: Kartik Ghosh.

The interactions between nanoparticles and biomolecules are necessary to further the use of nano-bio interfaces in biosensing, drug delivery and biofunctional materials. We examine the interaction of zinc oxide (ZnO) nanoparticles with the amino acid L-tryptophan in this paper using a mixture of spectroscopic and structural methods. ZnO nanoparticles were suspended in an aqueous solution and combined with tryptophan to facilitate surface adsorption to the nanoparticle. Optical absorption was analyzed and band gap energies determined by Tauc analysis via UV-Vis spectroscopy and gave values of about 3.3 eV of ZnO and the ZnO-tryptophan system. To investigate variations in the emission characteristics of a probe molecule (tryptophan) upon its interaction with nanoparticles of ZnO, the fluorescence spectroscopy technique was used in which an increase in the intensity and a shift in the spectral width were observed as the probe interacted with the nanoparticles, indicating a change in the local electronic environment. The hexagonal wurtzite structure of ZnO was verified by X-ray diffraction (XRD) and the crystalline phase was also found to be maintained after the interaction. These findings indicate that ZnO-tryptophan interactions happen at the nanoparticle surface, and only optical properties are affected, without any change in the crystal structure. In this work, the efficacy of using spectroscopic and structural methods in order to investigate nano - bio interactions is shown, and the manner of behavior of biomolecules at interfaces of nanoparticles.

#49 CLIMATE IMPLICATIONS FOR HABITABLE ZONE PLANETS IN SYSTEMS CONTAINING A NEARBY JUPITER

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

Gravitational interactions, orbital configurations and the existence of very massive planetary bodies determine the orbital configuration and dynamical stability of planetary systems. The architectures of the planetary systems and the possibility of a long-term, dynamically stable planetary system and habitable regime in the habitable zone of a G-type star were determined by dynamical simulations of planet formation processes in the neighborhood of a Jupiter-mass planet at 3 AU. To measure the effect of the giant planet on the mass, eccentricity, and orbital place of the inner planets, a series of N-body simulations, using the Mercury Hybrid Integrator, were done in both gas-rich residual disk phase and a gas-depleted phase. It was discovered that although an exterior Jupiter replica is present, a large proportion of interior planets have dynamically stable orbits throughout the simulated timescales out of which half of the surviving planets are super-Earths. The results indicate that the occurrence of an outer gas giant does not always cause the outer planetary systems to be ejected or destabilized. Mean-motion resonances, separation of the radii of the two mutually, and time-dependent changes in orbital eccentricity were measured to determine orbital stability of the resulting systems that provides a multi-parameter description of dynamical behaviour. Equilibrium temperatures and percent change in stellar flux were also calculated to evaluate habitability, which found multiple planets with insolation levels which remained within the circumstellar habitable zone. Moreover, the model of VPlanet Venus water loss was used to explore the evolution of climate and water retention in the atmosphere, which gives data on the long-term process of atmospheric escape and surface habitation in the face of stellar irradiation. All of these findings prove that systems that harbor an exterior analog of Jupiter may still contain dynamically and climatologically stable habitable planets, which has implications on the exoplanet formation theory and also a target choice in future observation overviews.

#50 FORMULATING CHITOSAN NANOPARTICLES LOADED WITH DOXORUBICIN AND A 77KS ADJUVANT FOR CANCER DRUG DELIVERY

Lana Janson, Faith Sheridan, Wade Van Riessen, Markos A. Georgy, Abhishu Chand. Physics, Astronomy, and Material Science. Faculty Advisors: Kyoungtae Kim, Robert A. Mayanovic

Chitosan nanoparticles have shown considerable promise for cancer drug delivery. As such, chitosan nanoparticles must retain the loaded drug in normal tissue while having the capacity to easily discharge the drug at lower pH values in the cancerous tissue. The objective of this study was to test the efficacy of drug delivery of chitosan nanoparticles loaded with doxorubicin (DOX), a 77KS adjuvant, and various surfactants. The chitosan nanoparticles (CSNPs) were prepared using dilute gelation by drop-wise addition of tripolyphosphate (TPP). Each set of CSNPs were incorporated with a 77KS surfactant, which is a pH-sensitive adjuvant for drug delivery. Additional batches were loaded with polyvinyl alcohol (PVA) and a separate batch was prepared with polyethylene oxide (PEO). The nanoparticles have been characterized using x-ray diffraction (XRD), transmission electron microscopy (TEM), and Fourier transform infrared spectroscopy (FTIR). The XRD and TEM results indicate that all CSNPs incorporated with 77KS have a significantly greater degree of crystallinity in relation to ones without the 77KS surfactant. The FTIR results confirm conjugation of DOX on the CSNPs. Culture studies using the HeLa cell line showed the CSNP samples caused higher anticancer activity than free DOX.

#51 LITHOSPHERIC STRUCTURE CONTROLS GEOCHEMICAL DIVERSITY ACROSS THE TERCEIRA RIFT, AZORES TRIPLE JUNCTION

Angel Doran. Geology. Faculty Advisor: Gary Michelfelder

The Azores archipelago sits at the intersection of three tectonic plates, where the Terceira Rift connects the Mid-Atlantic Ridge to the East Azores Fracture Zone. Volcanic compositions across the rift vary systematically, but the controls on this diversity remain debated. This study evaluates whether lithospheric thickness, the depth to the lithosphere-asthenosphere boundary (LAB), is a primary control on melt composition across the rift. Whole-rock geochemistry, phenocryst electron probe microanalysis, xenolith geochemistry, and pMELTS thermodynamic modeling were applied to samples from Faial (LAB ~40 km), Terceira, and São Miguel (LAB ~80 km). Results show a systematic west-to-east gradient in garnet-sensitive trace element ratios consistent with deeper melt initiation under thicker lithosphere. Thermodynamic modeling independently reproduces this gradient, yielding liquidus temperatures at Faial approximately 75–100°C higher than São Miguel. Terceira's anomalously low liquidus temperatures are consistent with extended crustal storage at the Pico Alto central edifice, suggesting LAB depth and crustal architecture operate as independent controls. Results support lithospheric thickness variation as a primary control on rift geochemical diversity. Radiogenic isotope analysis is identified as the required next step to evaluate source heterogeneity.

#52 FLUORNATROPYROCHLORE FOUND IN SYENITE EJECTA FROM AGUA DE PAU VOLCANO, SAO MIGUEL ISLANDS, AZORES ARCHIPELAGO

Zackary Rouser, Angel Doran. Geology. Faculty Advisor: Gary Michelfelder, Fei Wang

Fluornatopyrochlore [(Na, Pb, Ca, REE, U)₂Nb₂O₆F] is part of the pyrochlore-supergroup minerals (A₂B₂X₆Y), composed of two prefixes and one root name. The first prefix refers to the dominant anion, fluorine, in the Y-site. The second prefix relates to the dominant cation, sodium, in the A-site. Within the pyrochlore-supergroup, fluornatopyrochlore belongs to the NbO pyrochlore group. The phase occurs as reddish-orange, hexoctahedral, isometric crystals in the nepheline syenite ejecta of the Plinian Agua de Pau volcanic fall deposits. Some grains are twinned. It is associated with zircon, dalyite, astrophyllite in a matrix mainly of albite, aegirine, and quartz. Outside of the Azores, fluornatopyrochlore is a very rare phase found exclusively in rare-metal deposits. Single crystal XRD analysis shows that crystals are characterized by F dominance at the Y site, Na dominance at the A-site, and Nb dominance at the B site, based on the overall electroneutrality requirement of the structural formula.

#53 FISH TEETH AS A RECORD OF PALEOENVIRONMENTS

Alexis Capestro. Geology. Faculty Advisor: Lydia Tackett

Fish teeth are a robust record of marine vertebrates in the fossil record, and can also be informative about ecological structure. Here, we show the results of a comparative study between two marine limestones containing vertebrate teeth. To conduct this research, an acetic acid mixture was used to dissolve pieces of rock taken from the study site and was then strained into a three-stage sieve. The materials found in the 2 mm to 250 microns size range were looked at and picked through under a microscope. The results included a chondrichthyan denticle (shark skin scale) and two types of fish teeth, belonging to *Saurichthys* and *Gyrolepis*. This sample was compared with an overlying bed that contained abundant teeth and an ichthyosaur skeleton. This studied unit contained fewer teeth than the ichthyosaur bed but contained similar species. Using these results, we can conclude that this unit had lower abundance but likely represented a diverse marine ecosystem. Fish teeth can be a valuable resource when other vertebrate fossils are not preserved.

#54 THE IMPACTS OF FOOD INSECURITY IN THE OZARKS: LOW INCOME, LOW ACCESS RURAL COUNTIES

December Wolf. Geography, Geospatial, Planning. Faculty Advisor: Krista Evans.

This research investigates the barriers to fresh food opportunities in the rural Ozarks, such as transportation restraints and rural planning deficiencies. The study examines the contributing causes of “food deserts” by focusing on Ozark County, Missouri, Shannon County, Missouri, and Stone County, Arkansas. The project provides an intersectional set of data from USDA censuses and statistics which have been integrated with geographic patterns and historical background to provide a comparative study. The reports are presented alongside various regional maps to ensure geographic understanding of rural location and the transportation barriers faced by those living within “low income, low access” areas. Evidence has been analyzed to strategize methods that will best address the overall impact of food insecurity within rural communities, particularly those which have been designated as “low income, low access” in the Ozarks region. Solutions discussed encompass approaches that consider accessibility, autonomy, and the success of past interventions. Concrete working examples, such as mobile food markets and government programs, are evaluated and screened for potential implementation in “low income, low access” counties.

#55 PROPERTY VACANCY IN THE CITY OF ST. LOUIS, MISSOURI

Shey Delahunt. Geography, Geospatial, Planning. Faculty Advisory: Dr. Krista Evans.

St. Louis is the second-largest city in Missouri, and for generations, has served as an important urban center for transportation, trade, healthcare, and entrepreneurial development. Deindustrialization mixed with racial tensions, inequalities, and urban decentralization patterns began a decades-long cycle of population decline and unemployment increase in many parts of the city, with working-class, minority communities hit hardest. As of 2025, the city has 8,835 buildings and 12,927 lots sitting vacant; this has contributed to a 45% loss in tax revenue, with a cost increase of 30% for safety and 25% for property maintenance each year. Many of these vacant structures include homes, schools, and storefronts. The highest concentration of property vacancies are generally located in low-income, minority neighborhoods, which create safety, health, and economic issues for already-underserved communities. Vacant properties attract crime, drugs, and unsustainable real-estate practices, while pushing away helpful development and investments in city resources. Our research allowed us to identify practices and steps that communities, elected officials, and stakeholders/developers can take to respect each other's interests while maintaining the integrity of the planning process and the communities of focus.

#56 THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL IMPACT OF COMMERCIAL POULTRY PRODUCTION IN THE OZARKS REGION

Grace Wasson. Geography, Geospatial, Planning. Faculty Advisor: Krista Evans.

My research investigates the historical and modern impact of poultry production in the Ozark Region. Specifically I examine how the agribusiness giant Tyson Foods developed in Northern Arkansas and now exerts outsized influence on the political and social fabric of the area, and shapes current environmental and labor realities. Finally, my research discusses the failure of current state policies, and potential solutions to modernize poultry production for a more sustainable and equitable future.

#57 IMPACTS OF COST-OF-LIVING DRIVEN DOMESTIC MIGRATION ON FUTURE SUSTAINABILITY OF U.S. STATES

Emma Coombs. Geography, Geospatial, Planning. Faculty Advisor: Emily Frazier.

This study explores how domestic migration affects the sustainability of U.S. states. Increases in cost-of-living migration are driving significant population shifts in emerging urban areas around the U.S. Population fluctuations can stifle a state's growth and present sustainability issues such as housing cost increases, job competition, urban sprawl, water scarcity, and unanticipated demands on educational systems. This project utilizes U.S. census data and UN sustainability statistics to map and analyze sustainability challenges exacerbated by population shifts across emerging urban areas receiving large amounts of domestic migration. Results highlight multifaceted sustainability issues facing emerging urban areas and point to areas requiring policy attention to ensure a sustainable future.

#58 WHAT DO MOBILE BAY SEDIMENTS CONTAIN? ESTIMATING ORGANIC MATTER USING LOSS-ON-IGNITION

Jazmynn Brewer and Logan Wilson. McDonald County High School. Faculty Advisor: Keith Jones.

This study was to understand the amount of organic matter present in sediment collected from the Gulf of Mexico near Dauphin Island, Alabama. Organic matter is essential for supporting plant and animal life by providing nutrients and maintaining ecosystem health. (MARUM Center for Marine Environmental Sciences, n.d.). The loss-on-ignition (LOI) method was used to determine organic matter content (Abbott, 2005). Sediment samples were first dried to remove moisture and then heated at high temperatures to burn off organic material. The samples were weighed wet, and before drying, after drying, and after heating, and the percent of organic matter was calculated based on the dried and burned organic mass. Results showed that sample site 3 contained 73.41% organic matter, while sample site 7 contained 77.60%. These findings show that the sediment samples contain a high concentration of organic material. This suggests that the area may support a productive marine ecosystem and shows the importance of organic matter in life in the ocean environment (Repeta and Boiteau, 2017).

#59 “IF [THEY] BE MR. HYDE, I SHALL BE MR. SEEK”: INVESTIGATING CRAWDAD POPULATION IN MCDONALD COUNTY

Jayden Mustain. McDonald County High School. Faculty Advisor: Keith Jones.

In most of southwestern Missouri, residents use crawdads as bait for fishing, fish and mammals rely on them as a food source, and crawdads are an integral part of stream life. The goal of this study was to find where they reside. During the month of March, four different creeks part of the Elk River watershed were sampled, and crayfish were collected by hand from different habitats. When caught, the crayfish were kept in a bucket where I could note sex, species, length and total count. Location, water temperature, and substrate were also noted. The crayfish were released in the area where they were found. More crayfish were collected in areas up to a meter deep with slow moving water and had a substantial amount of leaves, rocks, or flood-brush. In the past decade, more people have been clearing the hills in the McDonald County area allowing for more gravel and sediment to flow into the creek, which could lead to crayfish population decline due to the loss of valuable hiding places. This study shows the areas that crayfish do well which can be used in conservation efforts in the case of a steep population decline.

#60 GROWTH RATE OF FAXONIUS LONGIDGITUS UNDER CAPTIVE CONDITIONS

Emma Cooper. McDonald County High School. Faculty Advisor: Keith Jones.

This experiment aims to understand the growth rate of the Long-pincered crayfish (*Faxonius longidigitus*). This species is characterized by its large size, blue-black coloration, and yellow pincers with a red tint, reaching maturity around 6 inches in length within 3-5 months. Understanding their growth is crucial for assessing their ecological impact on native species, with factors like dopamine potentially influencing growth. Specimens were collected from Little Sugar Creek in McDonald County, Missouri, housed in separate aquariums, and fed daily. Their growth was measured by weighing them on a scale.

#61 EVALUATING PATTERN-RECOGNITION SOFTWARE AS A TOOL FOR ANIMAL IDENTIFICATION

Kaberlyn Burchett. McDonald County High School. Faculty Advisor: Keith Jones.

Pattern-recognition software is becoming a promising non-invasive tool in biology because it can compare photographs of natural marking such as spots, stripes, blotches, and scale patterns. This project will examine whether this type of software can accurately identify animals from images and how reliable it is for future use. Although many published studies focus on identifying individual animals within a species, the results still show strong potential for border biological applications. Research on salamanders, frogs, sea turtles, and catsharks has shown that programs such as I3S Pattern, Wild-ID, and ManderMatcher can achieve high recognition success when the markings are stable and the images are clearer. However, the research also shows that reliability can decrease when photo quality is poor when animals change as they grow or when software matches are not checked carefully by a human researcher. In this study a selected image set will be tested with a pattern recognition software and compared with manual identification in order to measure consistency and accuracy. The goal is to determine whether this technology is dependable enough to be used as a research tool in the future biological and conservation studies.

#62 RESUSCITATION OF DORMANT MICROALGAE IN ALABAMA GULF SHORE SEDIMENT SAMPLES

Ellie Allgood and Lilly Reaves. McDonald County High School. Faculty Advisor: Keith Jones.

Microorganisms within marine sediment samples have been shown to survive in dormancy for long periods, remaining inactive until properly reintroduced to the ideal environment. We aimed to further validate the hypothesis that sediment samples can be resuscitated through the proper means. For our study, sediment samples from different locations were collected from Mobile Bay, Alabama during August of 2025 and transported to McDonald County High, then stored until needed. During this storage period, faux seawater mixtures of four different salinities were created, with ratios of 3.25%, 2.5%, 1.5%, and 0.7%. 100 mL of each saline mixture was deposited into beakers, each salinity having 10 beakers. Afterwards, five grams of sediment from each site were deposited into individual beakers, making 40 beakers total. Samples were then left to incubate under a UV light at room temperature for around two weeks before being logged for the first time, and then left for another twelve weeks with periodic logging. Data revealed an initial peak in microalgae populations after the first incubation, with a decline over the second incubation. This indicates that the microorganisms within our sediment, while resilient, cannot survive for long in improper environments, even after successful resuscitation.

#63 THE SKIN MICROBIOME OF EURYCEA TYNERENSIS: IMPLICATIONS FOR AMPHIBIAN HEALTH IN THE OZARKS

Dominick Trimble and Zoey Clower. McDonald County High School. Faculty Advisor: Keith Jones.

Many amphibian species are currently under threat due to habitat loss, human activity, and novel diseases. Currently, *Batrachochytrium dendrobatidis* (hereafter referred to as Bd) has plagued North American amphibian populations, eventually becoming endemic, with a new threat emerging from *Batrachochytrium salamandrivaorans* (hereafter, Bsal), which has infected European amphibians, and has affected salamanders with devastating impact. Our ongoing study is collecting data on the microbial communities found on the skin of Ozark salamanders, beginning with an Oklahoma salamander, *Eurycea tynerensis* captured in February of 2026. Swabs collected from the animal are cultured, with isolates being identified using gram staining, visual inspection, and DNA barcoding to determine species. Understanding the species found on the skin of Ozark salamanders will allow scientists to better respond to infections and predict the spread of these pathogens.

#64 INTERSPECIES SOARING BEHAVIORS IN OZARK VULTURES DURING A RANGE EXPANION IN *CORAGYPSATRATUS*

Abby Richards. McDonald County High School. Faculty Advisor: Keith Jones.

Cathartes aura and *Caragyps atratus*, the turkey and black vultures, respectively, are the only functional vulture species in the United States, making it extremely important to monitor their behaviors and populations. Because of a sudden range expansion likely spurred by climate change, *C. atratus* has begun to broaden its range Northward, increasing competition for *C. aura* and possibly causing behavioral changes in the two. In my study, I monitored soaring behavior in both species in order to identify patterns in group sizes and species ratios during a collection period spanning from December 2025 to March 2026. Once a kettle was located, species and environmental data was logged into an excel spreadsheet. A total of 44 sightings were recorded across the collection period, with 13.5% of individuals identified as *C. atratus* and 86.5% of individuals as *C. aura*. However, 56.8% of *C. aura* sightings were of lone individuals. Results show extreme sociality among *C. atratus*, and primarily solitary behavior in *C. aura*. Interestingly however, *C. aura* almost always outnumbered *C. atratus* in intraspecies kettles. Overall, this data suggests a complex relationship developing between the species, possibly foreshadowing increased competition and more dramatic niche partitioning between the two.

#65 CHARACTERIZATION OF TGP-E H172S

Brodie Mohler. Ozark High School. Faculty Advisor: Natasha Devore.

The goal of this project is to characterize the thermostable fluorescent protein TGP-E. The protein is a mutated version of the green thermostable fluorescent protein(TGP). A surface mutation was done on the protein by altering a residue histidine at the 172 location to serine(H172S). The mutation was expected to remove a potential residue associated with binding nickel. There is one remaining histidine at the 216 location. This study focused on determining the stability and efficacy of TGP-E H172S through several assays. A pH assay was performed, revealing that TGP-E H172S is most stable in basic conditions, with a pKa value of 6.96. TGP-E is more stable, with a pKa value of 6.6. A chemical stability assay revealed TGP-E H172S is less stable than TGP-E in guanidinium hydrochloride. Quantum yield data concluded that TGP-E H172S is more fluorescent than TGP-E. Similarly, a metal binding assay provided evidence that TGP-E H172S had a higher affinity for binding metals than the wild type, TGP-E. Temperature stability remained similar to TGP-E, with TGP-E H172S and TGP-E reaching half-fluorescence at 60°C. Protein crystallography trays were attempted, with no successful growth.

BIOLOGY

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

CURRENT RESEARCH

- **Michelle Bowe** – Phylogenetics, Plant Taxonomy, Evolution, Herbarium
- **Paul Durham** – Migraine, TMD, Nutraceuticals, Inflammation
- **Kathleen Church** – Behavioral Ecology, Conservation Behavior, Two-eyed Seeing
- **Courtney Coleman** – Genetics, Genomics, Grapevine Biology
- **Debra Finn** – Stream Ecology, Connectivity, Aquatic Insects, Communities, Populations
- **Brian Greene** – Herpetology, Snake Ecology, Conservation
- **Takehiro Kado** – Mycobacteria, Immunity, Membrane Dynamics
- **Kyoungtae Kim** – Nanotoxicology, Cell Traffic, Cancer Nanodrug Carrier
- **La Toya Kisson-Charles** – Pollutants, Aquatic Plants, Biology Education
- **Day Ligon** – Conservation, Herpetology, Physiological Ecology, Aquatic Ecology
- **Adrian Macedo** – Fish Ecology, Wildlife Management, Community Ecology
- **Sean Maher** – Mammals, Biogeography, Quantitative Biology
- **Alicia Mathis** – Behavioral Ecology, Predation, Territoriality, Chemical Communication
- **Babur Mirza** - Environmental Metagenomics, Microbial Ecology
- **Nadje Najar** – Behavior Ecology, Evolution, Ornithology
- **Avery Russell** – Behavioral, Evolutionary, Microbial Ecology
- **Alexander Wait** – Plant Ecology, Restoration, Conservation

CHEMISTRY & BIOCHEMISTRY

The Department of Chemistry & Biochemistry at Missouri State University has 15 tenured/tenure-track faculty, 2 instructors, 2 staff members, 17 graduate students, and 103 majors. The Department has maintained programs approved by the American Chemical Society Committee on Professional Training since 1974 and offers tracks designed to help students achieve successes in a variety of career directions, including graduate school, industrial applications, medical school, biotechnology, materials development, and environmental engineering. The primary goal of the department is to produce graduates with a sound background in the fundamental areas of chemistry and a working knowledge of modern instrumentation. Toward this end, all chemistry majors have the opportunity to experience hands-on training with a broad range of instruments in their course work, and all majors participate in undergraduate research, which offers opportunity for real-world application of coursework knowledge and helps to develop critical thinking skills.

CURRENT RESEARCH

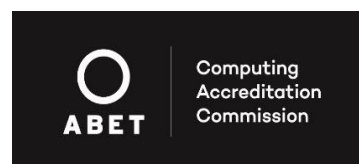
- **Tuhina Banerjee** – Biochemical, Biophysical and Nanotechnology
- **Gautam Bhattacharyya** – Organic Chemistry, Chemistry Education Research Qualitative Research Methods, Representational Competence
- **Bryan E. Breyfogle** – Electrochemistry of Materials, Chemical Education
- **Natasha DeVore**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

COMPUTER SCIENCE

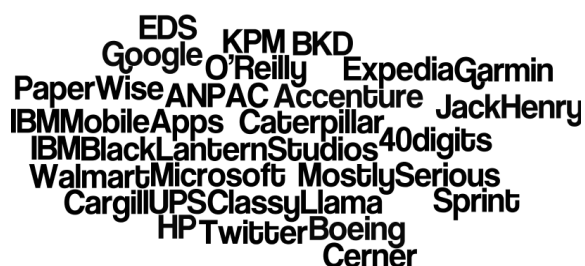
Computer science is a technology-oriented discipline whose fundamental principles combine theory, abstraction, and design. A solid foundation in the fundamental principles is critical to continued learning and adaptation to the technological changes which occur so rapidly in this discipline. The department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

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

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



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 2024 CS grads are projected at \$88,907. (See www.nacweb.org). As examples, graduates of the past five years or so work at these recognizable companies, and many have started their own software businesses.

CURRENT RESEARCH

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

COOPERATIVE ENGINEERING PROGRAM

Missouri State University and the Missouri University of Science & Technology are proud to offer degrees in Civil Engineering, Electrical Engineering and Mechanical Engineering on the Missouri State University campus. The three engineering degrees are granted by the Missouri University of Science and Technology, in cooperation with Missouri State University. Students are able to complete all four years of the degrees on the Missouri State University campus. The curriculum for the degrees is the same as the curriculum at the Missouri University of Science and Technology. The engineering degrees are accredited by ABET. Missouri State University also has a strong pre-engineering program for students who wish to 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. Engineering is an honorable profession. Civil Engineers assist in the design of buildings, bridges, dams, levees, water treatment facilities, drinking water facilities, transportation systems, and many other projects. Electrical Engineers assist in the development of power plants, robots, computer systems, electronic control systems, telecommunication systems, and many other projects. Mechanical Engineers assist in the development of internal combustion engines, steam turbines, gas turbines, refrigeration and air conditioning, robots, machine tools, production facilities, and many other products. Engineers assist with the design and/or manufacturing of almost every product that we use.

CURRENT FACULTY

- **Dr. Theresa Odun-Ayo** – PhD, Missouri University of Science and Technology
- **Dr. Douglas Carroll** – PhD, Missouri University of Science and Technology
- **Dr. Rohit Dua** – PhD, Missouri University of Science and Technology
- **Dr. Ryan Hutcheson** – PhD, Texas A&M University
- **Dr. Daniel Moreno-German** – PhD, Georgia Institute of Technology
- **Dr. Tayo Obafemi-Ajayi** – PhD, Illinois Institute of Technology
- **Dr. Shruti Pandey** - PhD, Dr. APJ Abdul Kalan Technical University
- **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 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 Masters program), and professional careers such as college teaching. We also have an excellent pre-engineering program.

CURRENT RESEARCH

- **William O. Bray** - Harmonic Analysis
- **Shahab Abbaspour** – Mathematical Proof in Mathematics Education, Leveraging Technology in Mathematics Education, Statistical and Machine Learning Application in Mathematics Education
- **Animesh Biswas** – partial differential equations, particular nonlocal analysis, application of nonlocal analysis, application of nonlocal analysis in roadway transportation networks, neural network
- **Yue Cui** – Statistics, Nonparametric models
- **Ngoc Do** – Inverse problems, Spectral theory
- **Adam Harbaugh** - Mathematics Education
- **Gay Ragan** – Mathematics Education
- **Jorge Rebaza**– 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
- **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

Nicholas Fleece
Jacob Miles
Shellie Myers

Gary Stafford
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
- **Justin Wittrock** – Observational astrophysics including transits and transit timing variations of exoplanets

SCHOOL OF EARTH, ENVIRONMENT AND SUSTAINABILITY

The School of Earth, Environment and Sustainability is staffed by 21 full-time faculty members. All majors and minors are focused on student involvement in intellectual studies and practical hands-on work in the field and the laboratory. The Center for Resource Planning and Management (CRPM) is an applied research and academic support unit of the Department. Another center within the Department is The Ozarks Environmental and Water Resources Institute (OEWRI). This institute supports efforts to protect and restore water quality and supply in the Ozarks Region. OEWRI initiates and supports research programs aimed at solving environmental problems by working in partnership and cooperation with university researchers, environmental groups, and governmental agencies.

CURRENT RESEARCH

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

2025 Winners

Biology: Ecology, Wildlife and Conservation

1st Place: *Jaslyn Johnson and Anna Faust*

EXPOSURE TO VARYING TEMPERATURES INFLUENCES AZOLLA GROWTH

Faculty Advisor: Dr. La Toya Kissoon-Charles

2nd Place: *Jaycie Balkenbush and Jordan Porsch*

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

Faculty Advisor: Dr. Alexander Wait

Biology: Cellular, Microbiology and Genetics

1st Place: *Daniel Kim, Abhishu Chand, Emma Braun, Nhi Le, Kyoungtae Kim*

AMMONIUM AND PHOSPHONIUM CHITOSAN POLYELECTROLYTES FOR GENE DELIVERY

Faculty Advisor: Dr. Reza Sedaghat-Herati

2nd Place: *Emma Goodwyn and Nicole Nalley*

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

Faculty Advisor: Dr. Paul Durham

Chemistry and Biochemistry

1st Place: *Abby Teitelbaum, Rahab Kanogo, Eniola Arogunyo, Mitchell Kim, Alexis Holyfield, Trishna Timalseena, Fei Wang, Santimukul Santra and Tuhina Banerjee*

REDOX-ACTIVE NANOSTRUCTURES WITH ULTRAHIGH CATALYTIC ACTIVITY FOR COLORIMETRIC APPLICATIONS

Faculty Advisor: Dr. Tuhina Banerjee

1st Place: *James Speake*

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

Faculty Advisor: Dr. Santimukul Santra

2nd Place: *Tim Howard*

REPRESENTATIONAL DETERMINISM IN NUCLEOPHILIC ALIPHATIC SUBSTITUTION AND ELIMINATION REACTIONS

Faculty Advisor: Dr. Gautam Bhattacharyya

Computer Science

1st Place: *Christopher Housholder, Zelun He, and Vivian Ning*

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

Faculty Advisor: Dr. Yifan Zhang

2nd Place: *Keegan Spell, Santimukul Santra, and Tuhina Banerjee*

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

Faculty Advisor: Dr. Mukulika Ghosh

Cooperative Engineering

1st Place: *Benjamin Cuebas and Justin Fausto*

DiSeCT (DISCRETE SEMICONDUCTOR CURVE TRACER)

Faculty Advisors: Dr. Rohit Dua

2nd Place: *Preston Carroll, Nathan Swan, Ben Alexander*

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

Faculty Advisor: Dr. Rohit Dua

School of Earth, Environment and Sustainability: Geology

1st Place: *Grace Chalfant*

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

Faculty Advisor: Dr. Toby Dogwiler

2nd Place: *Noah Short*

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

Faculty Advisor: Dr. Gary Michelfelder

School of Earth, Environment and Sustainability: Geography, Geospatial and Planning

1st Place: *Kayla May, Dr. Bob Pavlowsky, Marc Owen, Josh Hess, and Brianne Edwards*

IN-CHANNEL SEDIMENT DEPOSITION PATTERS ALONG 424 KM OF THE GASCONADE RIVER IN MISSOURI

Faculty Advisor: Marc Owen

Mathematics

1st Place: *Christopher Housholder and Layna Mangiapanello*
VC-DIMENSIONS OF SUBSETS OF THE HAMMING GRAPH
Faculty advisor: Dr. Steven Senger

2nd Place: *Christopher Housholder*
CONVERGENCE OF CLASSICAL AND NONLOCAL ATMOSPHERIC AND SEA
HARZARDS
Faculty Advisor: Dr. Animesh Biswas

Physics, Astronomy and Materials Science

1st Place: *Simarpreet K. Girn*
THE MYSTERIOUS FATE OF EXOMOONS AROUND WARM-JUPITERS
Faculty Advisor: Dr. Sarah Morrison

2nd Place: *Lana Janson, Wade Van Riessen, Markos A. Georgy*
CHITOSAN NANOPARTICLES INCORPORATED WITH VARIOUS SURFACTANTS
FOR OPTIMAL CANCER DRUG DELIVERY
Faculty Advisor: Dr. Robert A. Mayanovic

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>