

# 14<sup>th</sup> ANNUAL CNAS UNDERGRADUATE SYMPOSIUM



FRIDAY, APRIL 28, 2023

12:00 PM – 4:30 PM

PLASTER STUDENT UNION

STUDENT POSTERS DISPLAY

1:45 PM to 3:15 PM

PSU Ballroom West

CNAS RESEARCH IN:

SCIENCE

TECHNOLOGY

ENGINEERING

MATHEMATICS

HOSPITALITY

SPEAKER & AWARDS:

3:30 – 4:30 PM

PSU Ballroom East

SPEAKER:

Dr. Steven Senger,  
Department of  
Mathematics

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Tamera Jahnke, Dean

Jorge Rebaza, Associate Dean

Alicia Mathis, Biology Department Head

Adam Wanekaya, Chemistry & Biochemistry Department Head

Ajay Katangur, Computer Science Department Head

Doug Carroll, Cooperative Engineering Program Director

Toby Dogwiler, Geography, Geology & Planning Department Head

Kara Wolfe, Hospitality Leadership Department Head

William Bray, Mathematics Department Head

Robert Mayanovic, Physics, Astronomy & Materials Science Department Head

**Guest Speaker Dr. Steven Senger is the  
2022 recipient of the Atwood Research and Teaching Award and  
an Associate Professor in the Department of Mathematics**

**Title: DRAWING CONCLUSIONS FROM PICTURES**



**Abstract:** We'll briefly touch on some open problems in mathematics that don't take more than pen, paper and imagination to study. We'll also relate these abstract ideas to concrete subjects like data science

**About Dr. Steven Senger:** Dr. Steven Senger is a very active associate professor in the department of mathematics who excels in each of the areas of teaching, research, and service. Steven is a departmental leader in undergraduate mathematics research - currently working with five undergraduates and one graduate student on research in geometric combinatorics. He is also very active in his professional community as an editor of a journal, conference presenter, inviting guest speakers to MSU, and since 2020 he has published seven peer-reviewed research papers, including an interdisciplinary project with professors of physics and engineering here at MSU. He teaches courses of all levels, from general education courses such as pre-calculus, all the way to a new 700-level joint mathematics-computer science course he created on algorithm analysis as he has degrees in electrical and computer engineering in addition to his PhD in mathematics. Steven's dedication to teaching is legendary in the department of mathematics and beyond. His student ratings are consistently well above college averages, his written evaluations are heartwarming to say the least, and he impacts students' lives by helping them find jobs, presenting at conferences, and gaining admission to PhD programs. Steven is known as a caring professor who makes class fun. We are pleased to recognize Dr. Senger's excellence in all areas with this award.

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

# SUBMISSIONS 2023

<b>BIOLOGY</b>	
	--BIO: Ecology, Conservation and Wildlife--
<b>1</b>	<p><b>INSTRUMENTAL LEARNING OF MOTOR ROUTINES IN POLLEN FORAGING BEES IS NOTHING TO SNEEZE AT</b>  <u>Annaliese N. Novinger</u>, Katherine C. Naumer, Dalton M. McCart, Rachel Wilkins, Haley Muse, Tia-Lynn Ashman, Avery L. Russell, and Maggie M. Mayberry. Biology. Faculty Advisor: Avery L. Russell  <a href="https://youtu.be/aicHQfU9b7I">https://youtu.be/aicHQfU9b7I</a></p>
<b>2</b>	<p><b>PICKY EATERS: GENERALIST BEES SAMPLE POLLEN ON FLOWERS BY INGESTION BEFORE COLLECTION</b>  <u>Jenny K. Burrow</u>, Maggie M. Mayberry, Jacob S. Francis, Faith E. Dall, Michelle Bowe, Anne Leonard, and Avery L. Russell. Biology. Faculty Advisor: Avery Russell  <a href="https://youtu.be/EF-uCfa0axA">https://youtu.be/EF-uCfa0axA</a></p>
<b>3</b>	<p><b>EFFECT OF SOIL PH AND INDIGENOUS BACTERIAL POPULATIONS IN SELECTING RHIZOBIAL ENDOPHYTES WITHIN SOYBEAN ROOT NODULES</b>  <u>Erin Harrelson</u>. Department of Biology. Faculty Advisor: Dr. Babur Mirza  <a href="https://youtu.be/0JY6i8Bw6HI">https://youtu.be/0JY6i8Bw6HI</a></p>
<b>4</b>	<p><b>SELECTION OF RHIZOBIAL ENDOPHYTES WITHIN SOYBEAN ROOT NODULES.</b>  <u>Matthew Knoll</u>, <u>Autumn Bellew</u>, Cole Roman, Babur S Mirza. Biology. Faculty Advisor: Babur Mirza.  <a href="https://youtu.be/DbhmeLXERiY">https://youtu.be/DbhmeLXERiY</a></p>
<b>5</b>	<p><b>A MICROBIAL SOURCE TRACKING STUDY TO IDENTIFY FECAL CONTAMINATION IN A KARST WATER SYSTEM</b>  <u>Tyler Neff</u>, <u>Mercedez Hanlon</u>, William Durstock, Saki Urushidani, Marc Owen, Bob Pavlowsky, and Babur S Mirza. Biology. Faculty Advisor: Babur Mirza  <a href="https://youtu.be/piyuWp1LNCU">https://youtu.be/piyuWp1LNCU</a></p>
<b>6</b>	<p><b>INCREASED FINE SEDIMENTS MEANS DECREASED BIOMASS OF HYPORHEIC INSECTS IN OZARK STREAMS</b>  <u>Mackenzie Childers</u>, Jackson Winslow. Stream Ecology. Faculty Advisor: Debra Finn  <a href="https://youtu.be/VyBKTTYM76o">https://youtu.be/VyBKTTYM76o</a></p>

7	<p><b>NARROWING IN ON METHODS FOR ASSESSING HYPORHEIC COMMUNITITES IN OZARK STREAMS</b>  <u>Chatman Pardoe</u> and Jackson Winslow. Biology, Faculty Advisor: Debra Finn  <a href="https://youtu.be/-JyTKx9OXrU">https://youtu.be/-JyTKx9OXrU</a></p>
8	<p><b>ROCK BASS POPULATION PARAMETERS IN SOUTH DAKOTA</b>  <u>Tara Schnelting</u>, Brian Blackwell, Hae Kim, Todd Kaufman, Quinton Phelps. Biology. Faculty Advisor: Quinton Phelps.  <a href="https://youtu.be/ZiIe5bk8ZaY">https://youtu.be/ZiIe5bk8ZaY</a></p>
9	<p><b>LANDSCAPE ECOLOGY OF PRAIRIE PATCHES IN SOUTHERN MISSOURI</b>  <u>Emilyn Gilmore</u>, Bruce Schutte. Biology. Faculty Advisor: Sean Maher  <a href="https://youtu.be/_rxU2WyG7SU">https://youtu.be/_rxU2WyG7SU</a></p>
10	<p><b>A NOVEL APPROACH TO SCORING RHYTHMIC VARIATION IN EVOLVING WHITE-THROATED SPARROW (ZONOTRICHIA ALBICOLIS) SONGS</b>  <u>Caleb Hiers</u>, Shelby Palmer, Rachel Lange, Dan Zapata, Gleb Zhelezov. Biology. Faculty Advisor: Jay McEntee  <a href="https://youtu.be/oa7Iji8aRqM">https://youtu.be/oa7Iji8aRqM</a></p>
11	<p><b>OSPREYS DO NOT DISPLAY STRONG FOOTEDNESS AT A POPULATION LEVEL</b>  <u>Mackenzie McIntire</u>. Biology: Ecology, Wildlife and Conservation, Faculty Advisor: Jay McEntee  <a href="https://youtu.be/0BuepbTNOYk">https://youtu.be/0BuepbTNOYk</a></p>
12	<p><b>INTERSPECIFIC COMPETITION BETWEEN TWO WREN SPECIES</b>  <u>Jeffrey Gardner</u>. Biology. Faculty Advisor: Jay McEntee  <a href="https://youtu.be/-4G0FcT59G4">https://youtu.be/-4G0FcT59G4</a></p>
13	<p><b>THE PHENOLOGY OF A FEMALE CAROLINA WREN CALL HELPS ELUCIDATE ITS FUNCTION</b>  <u>Gabriela Rivero</u> and Jay McEntee. Biology. Faculty Advisor: Jay McEntee  <a href="https://youtu.be/fz2rwaJGllkw">https://youtu.be/fz2rwaJGllkw</a></p>
14	<p><b>NO METALS, PLEASE: DETRIMENTAL EFFECTS OF METAL CONTAMINATION ON MACROINVERTEBRATES IN A MISSOURI STREAM</b>  <u>Malachai Frisby</u>, Daphne Miles, Anna Faust, Jessica Stokesberry. Biology, Faculty Advisor: La Toya Kissoon-Charles  <a href="https://youtu.be/GI7NopHZp50">https://youtu.be/GI7NopHZp50</a></p>

15	<p><b>ALGAE GROWTH SURGES WHILE AQUATIC PLANTS DECLINE IN WINTER AND LOW WATER YEARS IN A SPRING-FED POND</b>  <u>Daphne Miles</u>, Hannah Whaley. Department of Biology. Faculty Advisor: La Toya Kissoon-Charles  <a href="https://youtu.be/uf58AKHdbqM">https://youtu.be/uf58AKHdbqM</a></p>
	<p>--BIO: Cellular, Microbiology and Genetics--</p>
16	<p><b>EFFECTS OF PRENATAL AND POSTNATAL COPPER OXIDE NANOPARTICLE EXPOSURE ON DISTAL COLONS AND MICROBIOME</b>  <u>Nicole Nalley</u>, Sophia Antonopoulos. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham  <a href="https://youtu.be/mM_48viBBHg">https://youtu.be/mM_48viBBHg</a></p>
17	<p><b>INVESTIGATION OF COPPER OXIDE NANOPARTICLES ON CRYOPRESERVED TRIGEMINAL GANGLION USED TO ESTABLISH PRIMARY CULTURES OF NEURONAL AND GLIAL CELLS</b>  <u>Mikayla Scharnhorst</u>, Sophia Antonopoulos. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham  <a href="https://youtu.be/BzdE2lUmjMM">https://youtu.be/BzdE2lUmjMM</a></p>
18	<p><b>GRAPE SEED EXTRACT PREVENTS GUT MICROBIOME DYSBIOSIS AFTER PRENATAL AND POSTNATAL DIETARY EXPOSURE TO COPPER OXIDE NANOPARTICLES</b>  <u>Emma Loder</u>, Sophia Antonopoulos. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham  <a href="https://youtu.be/Tghu1d9Zb9A">https://youtu.be/Tghu1d9Zb9A</a></p>
19	<p><b>IDENTIFICATION AND PREVENTION OF FRESHWATER BIOFOULING ON FLEXIBLE SENSOR SUBSTRATES</b>  <u>Daniel Garten</u>, <u>Emma Loder</u>, Sophia Antonopoulos. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham  <a href="https://youtu.be/BTzNsc5kFVv">https://youtu.be/BTzNsc5kFVv</a></p>
20	<p><b>DIETARY GRAPE SEED EXTRACT SUPPLEMENTATION INHIBITS NOCICEPTION AND MEDIATES GABAERGIC CHANGES IN A PRECLINICAL MODEL OF CHRONIC TMD</b>  <u>Daniel Garten</u>, Sophia Antonopoulos, Sara Woodman. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham  <a href="https://youtu.be/tOiBD0FyCXw">https://youtu.be/tOiBD0FyCXw</a></p>

21	<p><b>COPPER OXIDE NANOPARTICLES CAUSE TOXCICITY, STIMULATE EXPRESSION OF P-ERK AND P-P38, AND INHIBIT ATF2 AND C-JUN PROMOTER ACTIVITY IN THE WIDR HUMAN COLON EPITHELIAL CELL LINE</b></p> <p><u>Daniela Silva</u>, Sophia Antonopoulos. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham  <a href="https://youtu.be/b7QR0xbidl8">https://youtu.be/b7QR0xbidl8</a></p>
22	<p><b>PREVALENCE OF ANTIBIOTIC RESISTANCE IN THE ENVIRONMENT</b></p> <p><u>Brad Bateman</u>, <u>Suzzanne Jackson</u>. Biology. Faculty Advisor: Dick Wells  <a href="https://youtu.be/YKe3-tS65r0">https://youtu.be/YKe3-tS65r0</a></p>
23	<p><b>BIOCHEMICAL STUDY OF CHARACTERIZING THE INTERACTION BETWEEN QUANTUM DOTS AND ACTIN</b></p> <p><u>Emma Braun</u>. Biology. Faculty Advisor: Kyoungtae Kim  <a href="https://youtu.be/aCh9AGPNrRg">https://youtu.be/aCh9AGPNrRg</a></p>
24	<p><b>SNAPIN INTERACTION WITH NLRP</b></p> <p><u>Eric J. Byun</u>. Biology. Faculty Advisor: Christopher Lupfer  <a href="https://youtu.be/RDoavsHy8zM">https://youtu.be/RDoavsHy8zM</a></p>
<b>CHEMISTRY AND BIOCHEMISTRY</b>	
25	<p><b>ROLE OF PEGylated GOLD NANOPARTICLES ON INSULIN FIBRILLATION</b></p> <p><u>Ethan Grier</u>, Zachary Flint, Haylee Grannemann, Emma Taylor, Neelima Koti, Santimukul Santra. Tuhina Banerjee. Faculty Advisor: Tuhina Banerjee  <a href="https://youtu.be/mQLw_YPMWd8">https://youtu.be/mQLw_YPMWd8</a></p>
26	<p><b>TOWARD THE DESIGN OF A PLASMID VECTOR FOR EXPRESSION OF OMNILIGASE-1</b></p> <p><u>Jacob Linhardt</u>. Department of Chemistry and Biochemistry. Faculty Advisor: Keiichi Yoshimatsu  <a href="https://youtu.be/vOIXcsgkf4Q">https://youtu.be/vOIXcsgkf4Q</a></p>
27	<p><b>EFFECTS OF ATMOSPHERIC PLASMA TREATMENT ON THE TOXICITY OF POLYSTYRENE NANOPLASTICS IN WHEAT (TRITICUM AESTIVUM L.)</b></p> <p><u>Maximo Reyes</u>, Jessica Linson, Preston Clubb, Martin Winburn, Barry Cheung. Department of Chemistry and Biochemistry. Missouri State University; Department of Chemistry, University of Nebraska-Lincoln. Faculty Advisor: Cyren Rico  <a href="https://youtu.be/_NISny1AEvU">https://youtu.be/_NISny1AEvU</a></p>



28	<p><b>SCALLION (ALLIUM FISTULOSUM) GROWTH IN MARS SIMULANT SOIL TREATED WITH POSITIVE OR NEUTRAL CHARGED IRON NANOPARTICLES</b></p> <p><u>Jessica Linson</u>, Preston Clubb, Maximo Reyes, Brooke Winder, Riley Pope, Elim Horn. Department of Chemistry and Biochemistry. Faculty Advisor: Cyren Rico  <a href="https://youtu.be/tibSkX3rDTc">https://youtu.be/tibSkX3rDTc</a></p>
29	<p><b>STUDIES OF BACKBONE INTERCONVERSION AND DYNAMIC PROPERTIES IN DNA VIA NMR.</b></p> <p><u>Krusha Bhakta</u>, Chemistry. Faculty Advisor: Dr. Gary Meints.  <a href="https://youtu.be/2I5A84BGfgY">https://youtu.be/2I5A84BGfgY</a></p>
30	<p><b>PYROLYSIS OF SOYBEAN OIL-BASED TRIGLYCERIDES.</b></p> <p><u>Tanner Rust</u>, Chemistry and Biochemistry. Faculty Advisor: Matthew Siebert.  <a href="https://youtu.be/6uziEnizvM">https://youtu.be/6uziEnizvM</a></p>
31	<p><b>2D <sup>1</sup>H-NMR STUDIES OF A SINGLE MODIFIED LOCKED NUCLEIC ACID IN A SEQUENCES OF AN OTHERWISE UNMODIFIED DNA SEQUENCE.</b></p> <p><u>James N. Wilson</u>, Chemistry and Biochemistry. Faculty Advisor: Gary Meints  <a href="https://youtu.be/IVps33bQDV4">https://youtu.be/IVps33bQDV4</a></p>
32	<p><b>STRUCTURAL ENGINEERING OF THERMAL STABLE FLUORESCENT PROTEINS YTP-E-D.</b></p> <p><u>Caitlin Padgett</u>, Chemistry and Biochemistry. Faculty Advisor: Dr. Natasha DeVore  <a href="https://youtu.be/LJ8YZc9SRxc">https://youtu.be/LJ8YZc9SRxc</a></p>
33	<p><b>PURIFICATION OF CYP1A2</b></p> <p><u>Victoria Ogbeifun</u>, Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore  <a href="https://youtu.be/Shw5cMaOdI4">https://youtu.be/Shw5cMaOdI4</a></p>
34	<p><b>WILD-TYPE AND MUTANT CANINE-KRAS PURIFICATION AND CRYSTAL DEVELOPMENT</b></p> <p><u>Taryn Criblez</u>, Chemistry and Biochemistry, Faculty Advisor: Natasha DeVore  <a href="https://youtu.be/YwKjAMEzS6M">https://youtu.be/YwKjAMEzS6M</a></p>
	<b>COMPUTER SCIENCE</b>
35	<p><b>AN EVOLUTIONARY MULTI-AGENT POLICY OPTIMIZATION FRAMEWORK USING SELF-ADVERSARIAL TRAINING SCENARIOS</b></p> <p><u>Gavin Moore, C.J. Moore</u>, Computer Science, Faculty Advisor: Siming Liu  <a href="https://youtu.be/571Ox0rU1ro">https://youtu.be/571Ox0rU1ro</a></p>

36	<p><b>COMBINING MULTIPLE DEEP LEARNING MODELS FOR ONLINE SARCASM DETECTION</b>  <u>Nathan Hartzler, Brennan Dove, Nat Thompson, Joshua Stevens, Ingrid Perkins</u>  Faculty Advisor: Mohammed Y. Belkhouche  <a href="https://youtu.be/vl6oTzIPQfs">https://youtu.be/vl6oTzIPQfs</a></p>
37	<p><b>REAL-TIME HAND GESTURE RECOGNITION FOR DRONE CONTROL USING DEEP LEARNING</b>  <u>Tony Enrique, Astuhuaman Davila.</u> Faculty Advisor: Mohammed Y. Belkhouche  <a href="https://youtu.be/_-xzIuK9Cig">https://youtu.be/_-xzIuK9Cig</a></p>
	<p><b>COOPERATIVE ENGINEERING</b></p>
38	<p><b>ELECTRIC SKATEBOARD PROJECT</b>  <u>Ryan Flynn, Jacob Wooldridge, Cameron Howard.</u> Cooperative Engineering, Faculty Advisor: Doug Carroll  <a href="https://youtu.be/T9wuQSuTnB8">https://youtu.be/T9wuQSuTnB8</a></p>
39	<p><b>AUTO LAWN: WEBPAGE CONTROLLED YARD DEVICES.</b>  <u>Stephen Davis, Austin Crabtree, Justin Leuthauser.</u> Electrical Engineering, Faculty Advisor: Rohit Dua  <a href="https://youtu.be/Z3YWqHtyEIA">https://youtu.be/Z3YWqHtyEIA</a></p>
40	<p><b>MAGNETIC LINEAR ACCELERATOR</b>  <u>Jacob Adams, Cole Nichols, Hayden Windmiller.</u> Electrical Engineering, Faculty Advisor: Douglas Carroll  <a href="https://youtu.be/7zTnvqhMP4o">https://youtu.be/7zTnvqhMP4o</a></p>
41	<p><b>THE EFFECT OF TEMPERATURE ON ELECTROCHEMICAL REDUCTION OF CARBON DIOXIDE AND FORMATE PRODUCTION</b>  <u>Joshua Cox,</u> Missouri State University. Co-Authors: Dr. Daniel Moreno. Faculty Advisor: Daniel Moreno  <a href="https://youtu.be/mwg6lMKYXH4">https://youtu.be/mwg6lMKYXH4</a></p>
42	<p><b>THE EFFECT OF DIFFERENT TYPES OF CHARGING CYCLES AND COMPOSITION ON THE AGING OF LI-ION BATTERIES FOR ELECTRIC VEHICLES</b>  <u>Ana Torres Ladino,</u> Missouri State University Co-Authors: Dr. Daniel Moreno, Missouri State University, Dr. Tayo Obafemi-Ajayi. Faculty Advisor: Daniel Moreno  <a href="https://youtu.be/6J6lk20j154">https://youtu.be/6J6lk20j154</a></p>

<b>GEOGRAPHY, GEOLOGY AND PLANNING</b>	
	--GGP: Geology--
<b>43</b>	<p><b>HEAVY METAL CONTENT OF NATIVE PLANTS IN TRI-STATE MINING DISTRICT TO EVALUATE USE IN PHYTOREMEDIATION</b>  <u>Elizabeth Jones</u>. Geology, Geography, and Planning. Advisor: Mélida Gutiérrez  <a href="https://youtu.be/KVPwegljfD0">https://youtu.be/KVPwegljfD0</a></p>
<b>44</b>	<p><b>WATER QUALITY OF URBAN SPRINGS IN SPRINGFIELD, MO: DATA REVISITED</b>  <u>Megan Jones</u>. Geology. Faculty Advisor: Mélida Gutiérrez  <a href="https://youtu.be/ITWg1T-7Xng">https://youtu.be/ITWg1T-7Xng</a></p>
<b>45</b>	<p><b>SEQUIOTA CAVE SPRING AND POND INFLUENCE ON WATER QUALITY IN GALLOWAY BRANCH, SE SPRINGFIELD, MO</b>  <u>Oluchi Nweke</u>. Geography, Geology and Planning. Advisors: Hannah Bieser (OEWRI Research Assistant) &amp; Dr. Bob Pavlowsky  <a href="https://youtu.be/EEmQ8NkEamE">https://youtu.be/EEmQ8NkEamE</a></p>
<b>46</b>	<p><b>CAN BOOKS BE TOXIC? AN XRF ANALYSIS OF ARSENIC CONTENT IN BOOK COVERS FROM MEYER LIBRARY SPECIAL COLLECTIONS</b>  <u>Abby Momberg</u>. Department of Geology, Geography, and Planning. Faculty Advisor: Dr. Douglas Gouzie  <b>No video available</b></p>
	--GGP: Geography, Geospatial and Planning--
<b>47</b>	<p><b>WHO WELCOMES REFUGEES? REFUGEE RESETTLEMENT AGENCIES AND THIRD SECTOR ORGANIZATIONS IN THE SOUTHEASTERN U.S.</b>  <u>Genevieve Stark and Katherine Rudolph</u>. Geography, Faculty Advisor: Dr. Emily Frazier  <a href="https://youtu.be/qOy88SyP24k">https://youtu.be/qOy88SyP24k</a></p>
<b>48</b>	<p><b>BEACH EROSION TRENDS AT CRAB POND POINT SEA TURTLE NESTING SITE, SOUTHWEST COAST, JAMAICA.</b>  <u>Allison Gargus</u>, Geography. Advisors: Hannah Lowery, RA OEWRI, &amp; Dr. Bob Pavlowsky.  <a href="https://youtu.be/Ns3CJLTmWlg">https://youtu.be/Ns3CJLTmWlg</a></p>
<b>49</b>	<p><b>IMPROVED WATER ACCESS USING A RAINWATER CATCHMENT SYSTEM ON THE SOUTHWEST COAST OF JAMAICA</b>  <u>Valerie Holcomb</u>, Geography and Advisor: Bob Pavlowsky, GGP/OEWRI  <a href="https://youtu.be/g-pFfB7q5zA">https://youtu.be/g-pFfB7q5zA</a></p>

		<b>HOSPITALITY LEADERSHIP</b>
<b>50</b>	<b>DESTINATION IMAGE OF KANSAS CITY FROM THE PERSPECTIVE OF GENERATION Z</b> Alyson Morgans, Jake Boaz, <u>Madison Smith</u> , Dodge Schapeler. Hospitality Leadership. Faculty Advisor: Dr. Nancy Kageyama <a href="https://youtu.be/5JZcHNCWOwo">https://youtu.be/5JZcHNCWOwo</a>	
		<b>MATHEMATICS</b>
<b>51</b>	<b>DEVELOPING FRACTION-AS-MEASURE CONCEPTIONS TO SUPPORT GROWTH IN STUDENTS' ALGEBRAIC REASONING CAPACITIES IN MATH 101.</b> <u>Grace Herbold</u> and <u>Jake Gabbert</u> . Mathematics. Faculty Advisor: Patrick Sullivan <a href="https://youtu.be/f_Z1i_mA27w">https://youtu.be/f_Z1i_mA27w</a>	
		<b>PHYSICS, ASTRONOMY AND MATERIALS SCIENCE</b>
<b>52</b>	<b>IMPLEMENTATION OF A HOUGH TRANSFORM ON A FIELD PROGRAMMABLE GATE ARRAY</b> <u>Matthew Bruenning</u> , Physics, Astronomy and Materials Science. Faculty Advisor: Tiglet Besara <a href="https://youtu.be/pBjfZpHgzc8">https://youtu.be/pBjfZpHgzc8</a>	
<b>53</b>	<b>INVESTIGATING OUTCOMES OF INNER PLANET FORMULATION INFLUENCED BY A JUPITER-LIKE PERTURBER</b> <u>Simarpreet Girn</u> . Physics Astronomy/Material Sciences. Faculty Advisor: Dr. Sarah J. Morrison <a href="https://youtu.be/QOQ3_fNa0j8">https://youtu.be/QOQ3_fNa0j8</a>	
<b>54</b>	<b>ORBIT PERTURBATIONS TO HABITABLE ZONE PLANETS FROM MASSIVE PLANETS AT THE SNOWLINE AROUND M STARS AND G STARS</b> <u>Samuel Cope</u> , Bishwash Devkota, Missouri State University, Sarah J. Morrison <a href="https://youtu.be/_d4IFgyWUvg">https://youtu.be/_d4IFgyWUvg</a>	
<b>55</b>	<b>DEVELOPMENT OF ARTIFICIAL INTELLIGENCE-BASED FORCEFIELDS TO MODEL TUNNEL BARRIERS IN SUPERCONDUCTION QUBITS</b> <u>Rachel Lee</u> . Career Prep Physics and General Mathematics. Faculty Advisor: Ridwan Sakidja <a href="https://youtu.be/xsElw7jYSV0">https://youtu.be/xsElw7jYSV0</a>	

<b>56</b>	<b>FRACTAL ANALYSIS OF GRAVITATIONAL WAVES AND NOISE</b> <u>Yashasvi Moon</u> , Physics, Astronomy & Materials Science, Marco Cavaglia, Missouri University of Science and Technology. Faculty Advisor: Robert Mayanovic <b><a href="https://youtu.be/xYRlwzgiYo">https://youtu.be/xYRlwzgiYo</a></b>

## **#1 - INSTRUMENTAL LEARNING OF MOTOR ROUTINES IN POLLEN FORAGING BEES IS NOTHING TO SNEEZE AT**

Annaliese N. Novinger, Katherine C. Naumer, Dalton M. McCart, Rachel Wilkins, Haley Muse, Tia-Lynn Ashman, Avery L. Russell, and Maggie M. Mayberry. Biology. Faculty Advisor: Avery L. Russell  
Learning to forage is ubiquitous among animals, and bees foraging for floral nectar have been a model system for the study of learning for over 120 years. While bees often use sophisticated learned motor routines to extract nectar, bees must also forage for pollen. Yet the role of instrumental learning and motor routines in pollen foraging is barely understood. We investigated (1) whether bees learn and remember flower handling and motor routines to extract pollen from flowers, (2) whether the rate of learning differs when foraging on different plant species, and (3) whether learning improves the rate of pollen collection. We assessed learning and memory by allowing each bee to forage on flowers across two consecutive days. Our results demonstrate that pollen extraction from different plant species involves bees learning to perform motor routines specific to a species' flower morphology. Bees learned and retained memory of flower handling and motor routines for at least 24 hours, with some decay. The rate of learning also differed significantly among different plant species. Finally, learning significantly improved pollen collection. Our results demonstrate that, like nectar foraging, pollen foraging involves learning to optimize handling time and motor routines, and an increase in reward collection.

## **#2 - PICKY EATERS: GENERALIST BEES SAMPLE POLLEN ON FLOWERS BY INGESTION BEFORE COLLECTION**

Jenny K. Burrow, Maggie M. Mayberry, Jacob S. Francis, Faith E. Dall, Michelle Bowe, Anne Leonard, and Avery L. Russell. Biology. Faculty Advisor: Avery Russell

Determining how animals assess food quality is fundamental to understanding foraging behavior. Generalist bees collect floral nectar and pollen, and the quality of these two foods is highly variable among plant species. Given often strong nectar and pollen preferences, bees likely assess the quality of both foods. Yet while bees assess nectar quality while ingesting it, pollen is stored externally in pollen-baskets. We investigated how bumblebees might assess pollen quality, predicting they might assess quality by ingesting small amounts while foraging. We collected foragers from the field and quantified pollen species diversity and abundance in the pollen-baskets and gut. Field results in combination with a controlled lab assay established that foragers consume pollen directly from flowers. We also found that pollen foragers were more likely to have pollen in their crops than nectar foragers and that pollen diversity was greater for pollen foragers. Our results implicate ingestion and potentially gustatory cues as mechanisms used by generalist bees to assess pollen quality, suggesting that pollen and nectar are assessed similarly, even though stored very differently.

## **#3 – EFFECT OF SOIL PH AND INDIGENOUS BACTERIAL POPULATIONS IN SELECTING RHIZOBIAL ENDOPHYTES WITHIN SOYBEAN ROOT NODULES**

Erin Harrelson. Department of Biology. Faculty Advisor: Dr. Babur Mirza

Soybean plants fulfill most of their nitrogen requirement by developing symbiotic associations with four different rhizobial genera, including Bradyrhizobium, Sinorhizobium, Mesorhizobium, and genus Rhizobium. In general, members of Bradyrhizobium and Sinorhizobium have been reported as root nodule endophytes under acidic soils and alkaline soil conditions, respectively. So far, it is unknown whether the selection of rhizobial endophytes is regulated by their ability to survive under different soil pH or primarily driven by host plants regardless of their relative abundance in soil. This study was focused on the assessment of the potential role of soil pH in selecting rhizobial endophytes and determining whether the selection of rhizobial endophytes is controlled by their relative abundance in rhizosphere soil. In a greenhouse study, we inoculated soybean plants with different cell densities of Bradyrhizobium japonicum and Sinorhizobium fredii cultures. Plants were grown under three soil pH conditions. We assessed the distribution of rhizobial endophytes within root nodules and rhizosphere using high-throughput DNA sequencing of 16S rRNA gene amplicons. We observed significant differences in plant growth and selection of root nodules endophytes across different soil pH conditions. These results will be helpful in identifying better rhizobial bioinoculants under various soil pH conditions.

**#4 - SELECTION OF RHIZOBIAL ENDOPHYTES WITHIN SOYBEAN ROOT NODULES.** Matthew Knoll, Autumn Bellew, Cole Roman, Babur S Mirza. Biology. Faculty Advisor: Babur Mirza.

Soybeans can nodulate with different rhizobial genera. Previous field studies suggested that under acidic conditions, soybeans prefer *Bradyrhizobium* as a root nodule endophyte and under alkaline conditions *Sinorhizobium* dominates. So far, the role of soil pH and the age of the host plant in selecting rhizobial strains for root nodule endophytes is unknown. In the current greenhouse study, we planted soybeans in acidic, alkaline, and neutral sterilized sand and plants were inoculated at different plant growth stages with various cell densities of *Bradyrhizobium japonicum* and the *Sinorhizobium* USDA 191 strains. Using Next-DNA sequencing we assessed the relative distribution of rhizobial endophytes with soybean root nodules. We observed a preferred selection of *Bradyrhizobium* over *Sinorhizobium* under different pH conditions regardless of their abundance in rhizosphere soil. Currently, we are assessing data from the root nodules and rhizospheres of plants that were inoculated at different plant growth stages to determine if the age of the host plant plays any role in the selection of rhizobial endophytes. This study can be useful in identifying potential rhizobial strains for developing superior bioinoculants under different soil pH conditions.

**#5 - A MICROBIAL SOURCE TRACKING STUDY TO IDENTIFY FECAL CONTAMINATION IN A KARST WATER SYSTEM**

Tyler Neff, Mercedes Hanlon, William Durstock, Saki Urushidani, Marc Owen, Bob Pavlowsky, and Babur S Mirza. Biology. Faculty Advisor: Babur Mirza

Waterborne pathogens originating from human fecal material of infected individuals are one of the major areas of health concern in karst environments where water can easily flow from old leaky septic tanks and broken sanitary sewer lines into rivers and streams. The current study was focused on temporal monitoring of fecal indicator bacteria (FIB) in Sequiota Spring. Based on an initial Microbial Source Tracking (MST) study, we observed a high abundance of human fecal indicator bacteria (HFIB) (up to 110,000 cells/L water) in July 2020. The City of Springfield initiated a detailed assessment and repair plan for the upstream sanitary sewer lines as a remediation solution. Through this remediation effort, the HFIB significantly decreased (55 times reduction) in June 2022. We also assessed the waterfowl fecal indicator bacteria which were low ~300 cells/L and remained unchanged from the year 2020 to 2022. This suggests that the sewer repairs completed in the recharge area of Sequiota Spring were a primary cause of the reduction in HFIB. This study demonstrated a successful remediation effort in reducing human fecal contamination to reduce potential health risks at this site.

**#6 – INCREASED FINE SEDIMENTS MEANS DECREASED BIOMASS OF HYPORHEIC INSECTS IN OZARK STREAMS**

Mackenzie Childers, Jackson Winslow. Stream Ecology. Faculty Advisor: Debra Finn

In streams, the hyporheic zone provides habitat for many macroinvertebrates including larval insects that later emerge as adults. Most Ozark streams have coarse gravel beds but can vary in sand and silt content. We asked whether the percentage of fine sediment (% fines) impacts the standing biomass of hyporheic insects. In each of five Ozark streams with varying % fines, we pumped 8 liters of hyporheic water from six replicate hyporheic wells. In the lab the insects were sorted and identified. We calculated biomass by measuring body lengths and using published length-mass relationships. We found that as the % fines decreased, the overall biomass increased. Additionally, streams with lower percent fines had individuals with larger mean size, which makes sense because fine sediments clog the interstitial spaces in gravel leaving less room to grow and potentially limiting the types of taxa that could colonize there. Because aquatic insects are important to both stream and terrestrial food webs, it is important to manage streams in a way that limits fine sediments. Thus, our findings could be important for future management decisions.

## **#7 - NARROWING IN ON METHODS FOR ASSESSING HYPORHEIC COMMUNITIES IN OZARK STREAMS**

Chatman Pardoe and Jackson Winslow. Biology, Faculty Advisor: Debra Finn

Ozark streams are complex systems with high biodiversity. Invertebrates are particularly diverse and provide crucial biomass to food webs. Many invertebrates occur below the stream bed in the hyporheic zone. We commonly sample hyporheic invertebrates by hammering wells into the sediments and pumping water from a known depth. However, there is evidence that the hammering is a disturbance to invertebrates, so pumping immediately after well installation probably does not give an accurate picture of the whole community. In two consecutive years, we compared invertebrate communities collected immediately, 24 hours, or 7 days following well installation in an Ozark stream with high diversity. In October 2021, we installed 12 wells in a shallow glide. Six wells were sampled immediately, and six were sampled 7 days later. We repeated this design in October 2022, but waited just 24 hours before pumping the delayed and repeat samples. Results from 2021 showed that invertebrate abundances in delayed and repeat samples taken after waiting 7 days were higher than immediate samples. Conversely, 2022 results show that 24 hours is not long enough to allow similar communities to return. These results suggest the minimum time needed prior to sampling falls somewhere between one day and one week.

## **#8 – ROCK BASS POPULATION PARAMETERS IN SOUTH DAKOTA**

Tara Schnelting, Brian Blackwell, Hae Kim, Todd Kaufman, Quinton Phelps. Biology. Faculty Advisor: Quinton Phelps.

Many centrarchid species have been extensively studied throughout their ranges. However, little is known about Rock Bass *Ambloplites rupestris* (RKBS) populations in South Dakota waters. Our objective was to quantify RKBS population demographics in three eastern (Amsden, Enemy Swim, and Pickerel) and two western (Deerfield and Pactola) South Dakota waters. The eastern populations occur within the native range of RKBS, whereas the western populations are introduced. Data collected with modified fyke nets during the 2022 spring will be used to assess the relative abundance, size structure, and growth of the five populations. All collected RKBS were measured (mm), weighed (g), gender determined, and sagittal otoliths removed from a subsample (five fish per cm per sex, when available). Historically size structure is similar across four of the waters, but the Deerfield population has a smaller size structure. Recruitment is fairly consistent within all the populations. Growth varied geologically. The relative abundance and size structure trends will be presented. This study will provide baseline information concerning the dynamics of RKBS in South Dakota waters

## **#9 - LANDSCAPE ECOLOGY OF PRAIRIE PATCHES IN SOUTHERN MISSOURI**

Emilyn Gilmore, Bruce Schutte. Biology. Faculty Advisor: Sean Maher.

Habitat fragmentation is the process where large complex habitats are divided and separated into smaller ‘patches’ with less transition between one habitat type to the next. Fragmentation is largely an anthropogenic issue, caused by development, spread of agriculture and improper management of land. Prairies and grasslands are particularly at risk and these habitats are home to species of plants, mammals and other wildlife groups that rely on large unfragmented grasslands to thrive. The historic prairies of Missouri have been heavily fragmented and isolated from one another and many of the prairie patches are surrounded by agriculture and other less than ideal landcover types. Using QGIS and R, we show that increased agriculture surrounding a prairie has a negative impact on the plant community within the prairie patches of our study. Missouri’s landscape is dominated by agriculture and the remnants of prairie likely are becoming both encroached upon and isolated from one another by agricultural land use.



## **#10 – A NOVEL APPROACH TO SCORING RHYTHMIC VARIATION IN EVOLVING WHITE-THROATED SPARROW (ZONOTRICHIA ALBICOLIS) SONGS**

Caleb Hiers, Shelby Palmer, Rachel Lange, Dan Zapata, Gleb Zhelezov. Biology. Faculty Advisor: Jay McEntee.

Birdsong is a learned behavior and can therefore undergo rapid cultural evolution as new song variants arise within populations. For example, studies show that the White-throated Sparrow's (*Zonotrichia albicollis*) song is evolving across North America. Previously, most songs ended in a series of "triplets" consisting of three notes. Sometime after the 1960s, a new variant arose in western Canada that ended in a series of "doublets" consisting of two notes. A recent study found that the doublet variant has since spread rapidly eastward across the continent, replacing the triplet variant. We set out to document this shift in southwest Missouri and found that triplets were significantly more common than doublets, indicating that the new variant is not yet dominant here. Additionally, there was substantial disagreement among observers when attempting to subjectively score songs as doublet or triplet. To minimize observer bias, we developed an approach to quantitatively describe rhythmic variants. Songs were scored based on the time intervals between onsets of subsequent notes. Higher scores corresponded to the song's degree of doublet rhythm, while lower scores corresponded to triplet rhythms. This quantitative, repeatable approach will enable new analyses of rhythm variation and evolution in White-throated Sparrow songs

## **#11 – OSPREYS DO NOT DISPLAY STRONG FOOTEDNESS AT A POPULATION LEVEL**

Mackenzie McIntire. Biology: Ecology, Wildlife and Conservation, Faculty Advisor: Jay McEntee  
Some non-human animals display handedness, the preferential use of either the left or right limb, such that a bias is detectable at the population level. It has been suggested that the osprey, *Pandion haliaetus*, shows a population-level bias in foot stance while fishing, orienting with the left foot forward more often (Allen et al. 2018). The osprey comprises a single species with a worldwide distribution, making it a potentially valuable organism to weigh the relative influences of genetic vs. environmental factors. Therefore, we sought to investigate how much geographic variation exists in osprey footedness. We scored 341 photographs from the Macaulay Library in which an osprey carried a fish with one foot in front and the other in back and analyzed the scores using an exact binomial test. We were unable to reject the null hypothesis that New World and Old World ospreys show similar foot stance proportions. Unlike the prior study, we did not find evidence of strong footedness bias at a population level and were unable to reject the null hypothesis of no footedness despite a large sample. These results suggest that osprey populations do not exhibit a bias in foot stance preference.

## **#12 – INTERSPECIFIC COMPETITION BETWEEN TWO WREN SPECIES**

Jeffrey Gardner. Biology. Faculty Advisor: Jay McEntee

Competition between species is important because it can shape species ranges, define niches, and alter the evolution of the involved organisms. Carolina Wrens and Winter Wrens are closely related, territorial species that share similar habitat requirements, and it has been suggested that Winter Wrens sometimes displace Carolina Wrens from territories. Such displacement would be unusual among birds, as larger species are typically dominant over smaller species, and Winter Wrens are about half the size of Carolina Wrens. A sound playback experiment was used to determine whether Carolina Wrens defend territories against intruding Winter Wrens. Winter Wrens density was too low to perform a fully reciprocal experiment. Recorded calls of each of the species were made into 3-minute sections of audio playback, which were played to territorial Carolina Wrens. Carolina Wrens were not aggressive towards Winter Wren calls, while they were aggressive towards calls of their own species. If Winter Wrens indeed take over Carolina Wren territories, it does not appear that Carolina Wrens are putting up much of a fight. A future experiment to assess Winter Wren responses to Carolina Wrens would help determine whether Winter Wrens are aggressive towards Carolina Wrens.

### **#13 - THE PHENOLOGY OF A FEMALE CAROLINA WREN CALL HELPS**

**ELUCIDATE ITS FUNCTION** Gabriela Rivero and Jay McEntee. Biology. Faculty Advisor: Jay McEntee

Vocal communication among animals has been discussed and investigated for centuries. In birds, vocalization patterns tend to be better understood among males, as they often produce louder, more complex, or more auditorily pleasing vocalizations. Yet female birds regularly vocalize, and their vocal signals may have distinct functions from males. Carolina Wren females produce an insect-like trill in response to songs of their social mates. The purpose of this sound, which we term a “chatter”, is poorly understood. Some have hypothesized that its purpose is ‘mateguarding’, i.e. to prevent its social mate from breeding with another female. If this is indeed a function of the chatter, the chatter should be used frequently during the breeding season, when extra-pair copulations occur. To study this, we recorded Carolina Wren pairs between November 2022 and April 2023, and analyzed the rate of chatter per male song over time. We found that chatter rate decreases drastically as the breeding season approaches. This evidence points away from the hypothesis that females chatter to prevent extra-pair copulation, as they rarely use this vocalization during the breeding season. These findings suggest that researchers should not ignore the non-breeding season when investigating the function of vocal signals.

### **#14 - NO METALS, PLEASE: DETRIMENTAL EFFECTS OF METAL CONTAMINATION ON MACROINVERTEBRATES IN A MISSOURI STREAM**

Malachai Frisby, Daphne Miles, Anna Faust, Jessica Stokesberry. Biology, Faculty Advisor: La Toya Kissoon-Charles.

Centuries of lead mining in Missouri have led to high metal concentrations in streams. Big River in the Old Lead Belt of southeast Missouri contains sediments and detritus (decomposing plant material) with high lead and zinc concentrations. Aquatic macroinvertebrates are used as a water quality indicator because they live in sediment and feed on detritus. We conducted leaf pack experiments (mesh <1mm) using American Sycamore (*Platanus occidentalis*) leaves found on gravel bars upstream (reference) and downstream (mining) of mine tailings. We hypothesized that more macroinvertebrates would colonize non-contaminated leaf packs compared to contaminated packs, and more macroinvertebrates would colonize the reference reach compared to the mining reach. Contaminated leaf packs contained 26% fewer macroinvertebrates than non-contaminated packs, while the reference reach had 30% fewer macroinvertebrates than the mining reach. In the mining reach, 40% of the macroinvertebrates were from Ephemeroptera, Plecoptera, and Trichoptera (EPT) orders. In the reference reach, 48% of the macroinvertebrates were EPT. In contaminated leaf packs, 48% were EPT. In non-contaminated packs, 84% were EPT. While these orders are generally pollution intolerant, most of the specimens in the mining reach were from pollution tolerant taxa. Our findings indicate that mining contamination negatively impacts pollution-sensitive macroinvertebrate community composition.

### **#15 - ALGAE GROWTH SURGES WHILE AQUATIC PLANTS DECLINE IN WINTER AND LOW WATER YEARS IN A SPRING-FED POND**

Daphne Miles, Hannah Whaley. Department of Biology. Faculty Advisor: La Toya Kissoon-Charles.

Fluctuating water depths promote algae growth and cause shifts in dominant aquatic plant growth forms (i.e., submerged to emergent). Spring-fed impoundments in the Ozarks experience fluctuations in water depth. It is not well understood how changes in water depth impact aquatic vegetation in these systems. William’s pond, a spring-fed pond in the Ozarks, experienced lower than average water levels for almost 2 years due to a dam malfunction. To determine how aquatic vegetation responded to changes in water depth, we assessed vegetation cover before, during, and after this 2-year period. Smaller water volumes can result in high nutrient concentrations and excessive algal growth. Therefore, we hypothesized that decrease water depth will lead to increased filamentous algae and decreased submerged aquatic vegetation (SAV). In winter, water depth was below average, SAV cover decreased by 63%, and filamentous algae cover increased by 46%. In summer, water depth remained below average, SAV cover increased by 7%, and filamentous algae cover increased by 8%. Decreased SAV cover could be due to shading by increased filamentous algae and changes in water volume. Differences in impact to vegetation between seasons during low water years could be due to differences in water temperature and volume.

## **#16 – EFFECTS OF PRENATAL AND POSTNATAL COPPER OXIDE NANOPARTICLE EXPOSURE ON DISTAL COLONS AND MICROBIOME**

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

Nanoparticle industrial waste is increasing, potentially contaminating sources of drinking water. Ingestion of metal nanoparticles by adult animals is associated with digestive system pathology, but exposure during fetal development has yet to be studied. To investigate the effects of prenatal and postnatal exposure to copper oxide (CuO) nanoparticles, male and female Sprague Dawley rats consumed CuO nanoparticles (2 mg/L) via their drinking water from time of breeding throughout gestation. After birth, pups were allowed to nurse for 21 days while the mother continually ingested CuO. Pups were dissected between days 18-20 to study distal colon morphology via immunohistochemistry and microbiome composition via 16S next-generation sequencing in response to CuO exposure in utero and during nursing. CuO exposure caused no major differences in average weekly pup weight or changes in colon morphology based on staining for type I and III collagen. However, exposure mediated changes in the microbiome at the phylum level in male and female offspring. In summary, while no major morphological changes were observed in the colon, the addition of CuO nanoparticles to the diet of the parent rats caused slight dysbiosis in the microbiome of the offspring, which may predispose them to digestive system diseases later in life.

## **#17 - INVESTIGATION OF COPPER OXIDE NANOPARTICLES ON CRYOPRESERVED TRIGEMINAL GANGLION USED TO ESTABLISH PRIMARY CULTURES OF NEURONAL AND GLIAL CELLS**

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

Nanoparticles, such as divalent copper nanoparticles, can leach from devices and contaminate the surrounding environment, posing a threat to human health. The goal of our study was to investigate the cytotoxic effects of copper nanoparticles on trigeminal ganglion neurons and glia. Cryopreserved trigeminal ganglia were used to establish primary cultures that were incubated overnight with different concentrations of copper oxide (CuO) nanoparticles. Cell viability and expression of proteins implicated in cell stress pathways were determined. Cryopreservation of the trigeminal ganglion did not result in a decrease in cell viability of neurons (A $\delta$  or C-fiber), satellite glia, or Schwann cells with cell ratios similar to the in vivo ganglion. Overnight incubation with CuO (20 mg/L) was moderately toxic to glia but did not cause a decrease in neuronal viability. Expression of the MAP kinase P-ERK was increased in neurons and glia primarily when incubated with 20 mg/L CuO. However, levels of the MAP kinase phosphatase MKP1 were markedly increased only in neurons at 20 mg/L. Findings from our study provide evidence that CuO at 20 mg/L is more toxic to trigeminal glial cells than neurons, possibly because neurons express higher basal levels of the anti-inflammatory and neuroprotective protein MKP-1.

## **#18 - GRAPE SEED EXTRACT PREVENTS GUT MICROBIOME DYSBIOSIS AFTER PRENATAL AND POSTNATAL DIETARY EXPOSURE TO COPPER OXIDE NANOPARTICLES**

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

Nanoparticle use is increasing in several industries, increasing the likelihood of ground water contamination. Ingestion of nanoparticles may alter the gut microbiome and cause dysbiosis, which is implicated in the pathology of inflammatory diseases. The goal of our study was to investigate gut microbiome changes in offspring of rats after prenatal and postnatal dietary exposure to copper oxide nanoparticles (CuO NPs). We also investigated if dietary supplementation with grape seed extract (GSE) could prevent NP-induced dysbiosis. Sprague-Dawley male and female rats were exposed to CuO NPs (2 mg/L), GSE (0.05%), neither, nor both via their drinking water. Fecal and cecal samples were collected from the offspring, DNA isolated, and used for 16S next generation sequence analysis. Changes in the bacteria population, indicative of dysbiosis, were seen in fecal and cecal samples from male and female rats. GSE prevented the CuO NP-induced microbiome changes and increased the abundance of *Bacteroides acidifaciens*, a bacteria species reported to be protective against diabetes and obesity. Our findings suggest that exposure to CuO NPs causes mild dysbiosis and may increase the risk of diseases of the digestive system. Furthermore, dietary inclusion of the nutraceutical GSE, which is enriched in polyphenols, prevented CuO NP-mediated dysbiosis

## **#19 - IDENTIFICATION AND PREVENTION OF FRESHWATER BIOFOULING ON FLEXIBLE SENSOR SUBSTRATES**

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

There is an increasing demand for sensors that continuously monitor freshwater quality, but their performance can be greatly reduced by biofouling. The goal of this study was to identify via 16S and 18S rRNA next generation sequencing (NGS) prokaryotic and eukaryotic microorganisms that adhered to submerged flexible substrates and investigate coatings to prevent biofouling. Substrates including cyclic olefin copolymer, polyethylene terephthalate, and Kapton were suspended in aquariums filled with river, pond, or well water from the Springfield Missouri region and maintained at ~85°C to simulate summer conditions. Biological samples were mechanically removed and used for NGS analysis to identify adherent microorganisms and determine relative abundance. Possible anti-fouling effects of biological coatings that were applied as a thin layer was investigated using qPCR on samples submerged for 2 weeks. Proteobacteria were the most abundant bacteria on all substrates and water sources. The most prevalent eukaryotic biofouling organisms were diatoms in river water, green algae in pond water, and fungi in well water on all substrates. None of the coatings made a substantial difference in the amount of biofouling of the substrates. Future studies will be initiated to identify biofouling microorganisms on freshwater samples maintained at 45°C and other antifouling strategies

## **#20 - DIETARY GRAPE SEED EXTRACT SUPPLEMENTATION INHIBITS NOCICEPTION AND MEDIATES GABAERGIC CHANGES IN A PRECLINICAL MODEL OF CHRONIC TMD**

Daniel Garten, Sophia Antonopoulos, Sara Woodman. Department of Biology/Jordan Valley Innovation Center. Faculty Advisor: Paul Durham

The aim of this study was to investigate changes in mechanical nociception, GABAergic proteins in the trigeminal ganglion, and glial fibrillary acidic protein (GFAP) in the spinal cord in a preclinical model of temporomandibular joint disorder (TMD) and in response to grape seed extract (GSE) supplementation. The three experimental groups consisted of naïve, chronic TMD, and chronic TMD animals with GSE supplementation via their drinking water. To induce chronic TMD pathology, female Sprague-Dawley rats were injected with the inflammatory agent complete Freund's adjuvant (CFA) to cause trigeminal sensitization prior to prolonged jaw opening. GSE suppressed trigeminal nociception to mechanical stimulation with von Frey filaments. Spinal cord GFAP levels were elevated in response to TMD pathology and GSE supplementation caused repression of GFAP expression. In the trigeminal ganglion, neuronal levels of GAD 65/67 and GABAB, which are implicated in pain inhibitory pathways, were decreased in the TMD model compared to controls. These protein levels were increased in neurons of the GSE supplemented group compared to levels in the TMD animals. These results provide evidence that GSE functions to inhibit activation of astrocytes and stimulates expression of GABAergic proteins to suppress development of central and peripheral sensitization in a chronic TMD model.

## **#21 - COPPER OXIDE NANOPARTICLES CAUSE TOXICITY, STIMULATE EXPRESSION OF P-ERK AND P-P38, AND INHIBIT ATF2 AND C-JUN PROMOTER ACTIVITY IN THE WIDR HUMAN COLON EPITHELIAL CELL LINE**

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

Several industries are increasing their use of divalent copper nanoparticles (Cu NPs), which increases the likelihood of Cu NPs leaching into the environment and causing contamination of drinking water. The effects of ingestion of Cu NPs via contaminated drinking water on epithelial cells of the digestive track remain unknown. The goal of this study was to investigate overnight exposure to Cu NPs on cell viability, protein expression, and gene expression in the WiDr human colon epithelial cancer cell line. Cytotoxicity was measured using the CellTiter Proliferation and LIVE/DEAD Assay in response to copper chloride, nitrate, and oxide. Protein expression was determined by immunocytochemistry while promoter activity was investigated via transient transfection and luciferase reporter assay. Dose-dependent decreases in cell viability were observed with all forms of Cu NPs. Increased expression of the pro-apoptotic proteins P-ERK and P-p38 were observed with 20 mg/L CuO. Promoter activity of the transcription factors ATF2 and c-Jun were decreased by 20 mg/L CuO. Our results provide evidence that Cu NPs dose-dependently reduce cell viability of human colon epithelial cells. The cytotoxic effects of Cu NPs involve increased expression of the apoptotic proteins P-ERK and P-p38 and suppression of transcription factors that mediate cell survival.

## **#22 - PREVALENCE OF ANTIBIOTIC RESISTANCE IN THE ENVIRONMENT**

Brad Bateman, Suzanne Jackson. Biology. Faculty Advisor: Dick Wells

## **#23 - BIOCHEMICAL STUDY OF CHARACTERIZING THE INTERACTION BETWEEN QUANTUM DOTS AND ACTIN**

Emma Braun. Biology. Faculty Advisor: Kyoungtae Kim

Quantum dots are nano-sized semiconductor crystals capable of emitting a wide range of photobleaching fluorescence. As such, they are highly sought after for various biomedical applications. However, recent reports show that quantum dots are toxic to cells. Therefore, it is important to study the toxicity mechanism of quantum dots to develop a safer quantum dot for biological applications. Although QDs have been reported to enter various cell types via endocytosis, current studies regarding QDs toxicity overlooked the direct interaction between QDs and cellular components. Thus, our study aims to further explore the interaction of quantum dots with yeast protein. Our data showed that QDs could interact with a number of proteins associated with transcription, translation, mitochondria, vesical trafficking, and actin cytoskeleton. We further assessed the binding of QDs with actin by performing a native gel electrophoresis. We were able to verify the binding of G-actin to quantum dots. In addition, we saw the quenching of actin proteins' intrinsic fluorescence upon adding quantum dots, suggesting the direct interaction between QDs and actin.

## **#24 - SNAPIN INTERACTION WITH NLRP**

Eric J. Byun. Biology. Faculty Advisor: Christopher Lupfer

SNAPIN proteins are responsible for vesicle transportation and regulating neurotransmitter release through binding with the BLOC1 complex. On the other hand, Nucleotide-binding and Leucine-rich repeat proteins, known as NLRPs, have multiple functions in the human immune system. NLRP 2 and 7 regulate fertility and embryo development through DNA methylation. NLRP 3 induces pyroptosis and releases inflammatory cytokines IL-1 $\beta$  and IL-18, which activates inflammasomes. NLRP 12 modulates the immune response to pathogens through inflammation. Exploring the interaction between SNAPIN and NLRPs will reveal the unknown protein function and mechanisms, along with the discovery of how vesicle transportation is related to the immunological functions of NLRPs. With the Yeast 2-hybrid (Y2H) assay, yeasts containing NLRP plasmids were mated with yeasts containing the SNAPIN plasmid. Mated yeasts were then grown on double dropout (DDO), triple dropout (TDO), and quadruple dropout plates (QDO), which are used to determine a successful interaction. Mated yeasts containing NLRP 3, 7, and 12 with SNAPIN showed successful growth on QDO, indicating successful protein interaction. However, NLRP 2 did not interact with SNAPIN in the Y2H Assay. Further research will be done on the proteins showing a positive interaction in a human cell system.

## **#25 – ROLE OF PEGylated GOLD NANOPARTICLES ON INSULIN FIBRILLATION**

Ethan Grier, Zachary Flint, Haylee Grannemann, Emma Taylor, Neelima Koti, Santimukul Santra Tuhina Banerjee. Chemistry and Biochemistry. Faculty Advisor: Tuhina Banerjee

The mechanism of amyloid fibrillation persists as one of the more difficult problems within the realm of biochemistry. The etiological nature of this reaction has provoked numerous studies, though the thermodynamic stability of the fibrils combined with the neuro-specific mediums in which they form remain insurmountable obstacles. Therefore, compounds that could kinetically attenuate this reaction are of particular interest. Gold nanoparticles are particularly suited for this task as they remain stable and colloidally dispersed at physiological conditions which gives them a persisting and widespread reach in biological environments. In this study, gold nanoparticles are synthesized via the reduction of gold chloride by various discrete sizes of polyethylene glycol (PEGn) which impacts the magnitude of surface charge retained by the resulting nanoparticles. The kinetic potency of the gold nanoparticles was then determined by thioflavin T (ThT) fluorescence assays, which allows for the real-time monitoring of amyloid fibril formation. Insulin was used as the amyloid protein due to its accessibility as well as its tendency to quickly form fibrils in moderately extreme conditions (50 °C and pH 3.0).

## **#26 – TOWARD THE DESIGN OF A PLASMID VECTOR FOR EXPRESSION OF OMNILIGASE-1**

Jacob Linhardt. Chemistry and Biochemistry. Faculty Advisor: Keiichi Yoshimatsu.

Large and complex peptides are becoming increasingly prevalent in the pharmaceutical industry, leading to interests in exploring new ways to synthesize long peptides. This led to the development of Omniligase-1 - an enzyme that joins two peptide fragments together. Traditional stitching methods use harsh chemicals; therefore, Omniligase-1 allows for a greener route for the synthesis of long peptides. Our goal is to streamline the production of Omniligase-1. The conventional method uses multiple organisms to produce Omniligase-1 but expressing the enzyme only in *E. coli* would allow for facile production. In this work, based on the sequence of Omniligase-1 retrieved from the protein data bank (PDB), I've designed a plasmid vector for expression of Omniligase-1 in *E. coli*. The amino acid sequence was verified by comparing with the information on literature (Ana Toplak et al. Computational and Structural biotechnology, 2021, 19, 1277-1287). The final goal of this work is to increase the access of a synthetic route to long peptides by improving the efficiency of peptide stitching reactions and decrease the environmental impact of the reaction.

## **#27 - EFFECTS OF ATMOSPHERIC PLASMA TREATMENT ON THE TOXICITY OF POLYSTYRENE NANOPLASTICS IN WHEAT (TRITICUM AESTIVUM L.)**

Maximo Reyes, Jessica Linson, Preston Clubb, Martin Winburn, Barry Cheung, Department of Chemistry and Biochemistry. Missouri State University; Department of Chemistry, University of Nebraska-Lincoln. Faculty Advisor: Cyren Rico

Nanoplastics are a broad category of emerging contaminants with very little known about the long-term effects they have on the environment. This study examines the effects of nanoplastic contamination, through various stages of degradation, on wheat plants. To study this, 210 nm polystyrene nanospheres in solution were degraded using atmospheric plasma treatment into four stages of degradation. Wheat plants were contaminated with these four sample groups and grown to term. Physical properties of the plants were analyzed, along with chlorophyll content and lipid peroxidation. Results showed subtle correlation between nanoplastic degradation and plant performance.

### **#28 - SCALLION (ALLIUM FISTULOSUM) GROWTH IN MARS SIMULANT SOIL TREATED WITH POSITIVE OR NEUTRAL CHARGED IRON NANOPARTICLES**

Jessica Linson, Preston Clubb, Maximo Reyes, Brooke Winder, Riley Pope, Elim Horn.  
Department of Chemistry and Biochemistry. Faculty Advisor: Cyren Rico

In competition with many universities across the United States, Dr. Cyren Rico's research lab participated in the Plant the Moon-Plant Mars challenge. We received Mars simulant soil to grow Scallions (*Allium fistulosum*) in the presence of iron nanoparticles. Positive and neutral charged iron nanoparticles were added to the soils at four concentrations: 0x, 25x, 10x, and 5x dilution factors of the stock solution. After eight weeks of growth in a growth chamber, the Earth soil plants produced significantly more biomass and greater root and shoot lengths than the Mars simulant. Within the treatment types, however, there was no statistical trend between dilution factors or charge of the iron nanoparticles. The lab will continue to participate in the Plant the Moon/Plant Mars challenge to further the understanding of plant growth in space.

### **#29 – STUDIES OF BACKBONE INTERCONVERSION AND DYNAMIC PROPERTIES IN DNA VIA NMR.**

Krusha Bhakta, Chemistry. Faculty Advisor: Dr. Gary Meints.

The palindromic DNA sequence [5'-GATAGCGCTATC-3'] (GCGC) was analyzed via the 2D NMR techniques of <sup>1</sup>H-<sup>1</sup>H NOESY and <sup>1</sup>H-<sup>31</sup>P HSQC. Chemical shifts and sugar-phosphorus interactions were determined for each phosphorus position in the GCGC sequence at 25 and 35 °C. These assignments were then applied to 1D <sup>31</sup>P spectra at the temperatures: 5, 10, 15, 20, 25, 30, and 35 °C. Values determined from the 1D <sup>31</sup>P spectra were then used to calculate the constants K, %BII, and ΔG. These values can provide insight on the recognition involved in base excision repair. Additionally, the sequence [5'-GATAGC\*GCTATC-3'] (GmeCGC), where C6 is methylated, is currently being examined against the GCGC sequence. Methylation of DNA serves many roles in biological processes. Comparison of this interaction to the GCGC sequence may elucidate backbone interactions involved in the DNA strand.

### **#30 – PYROLYSIS OF SOYBEAN OIL-BASED TRIGLYCERIDES.**

Tanner Rust. Chemistry and Biochemistry. Faculty Advisor: Matthew Siebert.

The world today relies on combustion-based fuel for a variety of reasons, namely quick and easy transportation. However, fossil fuels are not expected to last forever. Biodiesel, one renewable alternative, comes with its own downsides. Biodiesel can gel in cold environments and may leave residue in an engine. An alternative fuel derived from the pyrolysis of soybean oil could be an attractive option if it functions as an analog of fossil fuels without the downsides of biodiesel. Simulations of the pyrolysis of soybean oil-based triglycerides (SOBTs) were performed at 2000K for 10 cells containing 64 triglycerides each. The products showed similarities to fossil fuels and biodiesel.<sup>3</sup>

### **#31 – 2D <sup>1</sup>H-NMR STUDIES OF A SINGLE MODIFIED LOCKED NUCLEIC ACID IN A SEQUENCES OF AN OTHERWISE UNMODIFIED DNA SEQUENCE.**

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

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

### **#32 - STRUCTURAL ENGINEERING OF THERMAL STABLE FLUORESCENT PROTEINS YTP-E-D.**

Caitlin Padgett, Chemistry and Biochemistry. Faculty Advisor: Dr. Natasha DeVore.

The purpose of this research is to determine the structure of the thermal stable fluorescent protein YTP-E-D and to determine the quantum yield of the protein. This protein is a mutation of the yellow thermostable protein (YTP). YTP was developed by mutating a histidine located under the chromophore into a tyrosine (H197Y). Our target is to improve overall fluorescence. To accomplish this, we altered the chromophore using site-directed mutagenesis to mutate glutamine 66 to glutamate and glutamate 148 to aspartate in YTP to form a mutant we named YTP-E-D. The protein's quantum yield was determined to be 0.0099 which decreased compared to YTP-E with a quantum yield value of 0.0323. We have obtained the YTP-E-D crystal structure with a resolution of 2.7 Å to understand why the E148D mutation improved stability. We are in the process of refining YTP-E-D structure. This structure will act as a guide in improving the quantum yield and help us understand why the quantum yield decreased. In the future we plan to test the properties of thermal stability and pH stability of YTP-E-D.

### **#33 - PURIFICATION OF CYP1A2**

Victoria Ogbeifun. Chemistry and Biochemistry. Faculty Advisor: Natasha DeVore.

Cytochrome P450s (CYPs) are a family of heme proteins that are vital to breaking down foreign materials and compounds within mammals. Canine CYP1A2 is a cytochrome P450 enzyme that is specifically found in dogs. However, there are key metabolic differences between the Canine CYP1A2 and Human CYP1A2. For example, humans seem to tolerate compounds such as caffeine, while dogs tend to experience noxious effects. This poses the question of what are the differences that exist between the canine version of these enzymes and their human counterparts. The goal of this study is to examine the protein activity of canine CYP1A2. This project focused on the expression of the CYP1A2 in E. coli bacteria to purify them through nickel affinity chromatography. After purification, the purity will be measured using UV/vis spectroscopy and sodium dodecyl sulfate–polyacrylamide gel electrophoresis (SDS-PAGE). The results show that there was no proper purification based on the binding assay as well as the SDS PAGE and UV/vis spectra. Interestingly, the positive control that was run with human CYP2C9 also did not show signs of purification. Therefore, this project was not able to show any stable evidence of CYP1A2 purification nor the purification of the positive control CYP2C9.



### **#34 - WILD-TYPE AND MUTANT CANINE-KRAS PURIFICATION AND CRYSTAL DEVELOPMENT**

Taryn Criblez, Chemistry and Biochemistry, Faculty Advisor: Natasha DeVore

This research's purpose is to express and purify the wild-type canine-KRAS protein and the mutant canine-KRAS protein. Once the proteins are purified the goal is to grow crystals of both the wild-type and mutant canine-KRAS protein that can be put through X-ray crystallography to determine their three-dimensional structure. To begin the process the thawed wild-type or mutant canine-KRAS protein was lysed using sonication. The proteins were centrifuged, before being purified using a Nickel affinity column. The elutant from the Nickel affinity column was then purified further by ion exchange chromatography, the elutant from this column then had thrombin added to the sample. The elutant from the ion exchange column was then further purified by nickel affinity column chromatography to remove the histidine tag. The pure protein after the column chromatography was then ran through gel electrophoresis to ensure the protein was pure. The proteins are both currently in the crystal growth stage that once complete will allow for the protein's crystals to be analyzed by exposure to X-rays.

### **#35 - AN EVOLUTIONARY MULTI-AGENT POLICY OPTIMIZATION FRAMEWORK USING SELF-ADVERSARIAL TRAINING SCENARIOS**

Gavin Moore, C.J. Moore, Computer Science, Faculty Advisor: Siming Liu

Multi-Agent Reinforcement Learning (MARL) has been highly effective in training adept artificial intelligence (AI) models for multi-agent problems. MARL systems are capable of outperforming humans at many tasks, particularly those with a high degree of micromanagement. In MARL agents adopt effective "policies" that dictate their actions by "learning" from data in their environment, but often a model's bias toward a good policy will prevent them from finding the best policy. This is known as the exploration-exploitation tradeoff. Within this research we expand upon existing agent training platforms to create a novel environment, Multi-SMAC, that fosters policy improvements through adversarial training scenarios. We present an evolutionary framework in which new models are trained against agents employing previous policies to provide increasingly effective results. Each new model or "generation" improves upon existing results by learning how to outperform the previous policy. We train Multi-Agent Proximal Policy Optimization (MAPPO) actor-critic networks to provide fine-grain policy updates to individual agents within a team. Results show that, under our approach, as a model's generation increases it becomes more difficult to outperform, requiring a longer training time to beat the previous policy. This shows our method to be an effective policy optimization framework within MARL.

### **#36 - COMBINING MULTIPLE DEEP LEARNING MODELS FOR ONLINE SARCASM DETECTION**

Nathan Hartzler, Brennan Dove, Nat Thompson, Joshua Stevens, Ingrid Perkins Computer Science. Faculty Advisor: Mohammed Y. Belkhouche

This project trained a deep-learning model to detect sarcastic text. We used Bidirectional Encoder Representation from Transformers (BERT), a deep-learning model for natural language processing. BERT was pre-trained to recognize the English language from processing over six-million examples of Wikipedia entries and a collection of books. To train on sarcastic text, we used transfer learning to finetune four separate BERT models on each of the sarcasm datasets (Twitter, sitcom transcripts, Reddit, and news headlines). The trained models are deployed into a web server. We implemented a browser plugin to extract text from web pages and pass it through the trained sarcasm models. Each model provides a classification confidence value (51% to 99% if the input text is sarcastic). We used a voting algorithm to select the best prediction. We tested this system on real-world data such as Amazon product reviews and current news headlines. The developed method showed promising results in detecting sarcastic text

### **#37 – REAL-TIME HAND GESTURE RECOGNITION FOR DRONE CONTROL USING DEEP LEARNING**

Tony Enrique Astuhuaman Davila. Computer Science. Faculty Advisor: Mohammed Y. Belkhouche.

In this research, we present an approach for human-drone interaction through real-time hand gesture recognition using computer vision and deep learning techniques. Our system aims to provide an intuitive method of controlling UAVs, enhancing their accessibility for various applications, such as search and rescue, aerial photography, and surveillance. The system employs a Neural Network (NN) model to classify hand gestures captured by a camera mounted on the drone. The model is trained on a dataset of hand keypoints extracted using Google's MediaPipe. The keypoints are pre-processed to obtain relative coordinates and normalized to create a robust representation of the gestures. We implemented eight distinct hand gestures for drone control, including takeoff, landing, ascend, descend, flip left, flip right, move left, and move right. The system demonstrates real-time performance and is capable of recognizing gestures with 98% accuracy. Our research demonstrates the potential of using hand gesture recognition for intuitive human-drone interaction, opening new directions for drone applications, and enhancing user experience. Future work could explore the integration of additional gestures for more complex drone maneuvers and improving robustness in diverse environmental conditions.

### **#38 - ELECTRIC SKATEBOARD PROJECT**

Ryan Flynn, Jacob Wooldridge, Cameron Howard. Cooperative Engineering, Faculty Advisor: Doug Carroll

Our product aims to provide an alternate means to inner city commuting. To do this, we selected the longboard as the framework around which our project would be constructed. To make this product more competitive and enjoyable to use, we wanted it to be self-propelled via electric motors. Electric longboards have long since been a product available to the general public, so we wanted to make our solution stand out and exceed expectations. To do this we have decided to implement self-balancing control which would eliminate the need for traditional joystick throttle control which can be challenging to use and can be very sensitive. Similar to a Segway, leaning forward would cause the board to accelerate while leaning back would cause the motors to brake. We believe that combining the relaxed feeling of riding a longboard with the intuitive controls of a Segway would result in an incredible riding experience that would make inner-city commuting not only safer and easier but also lots of fun which skateboarding and longboarding hobbyists would enjoy. Finally, our product includes a custom hand controller that displays information such as speed, trip distance, battery status, and power consumption.

### **#39 - AUTO LAWN: WEBPAGE CONTROLLED YARD DEVICES.**

Stephen Davis, Austin Crabtree, Justin Leuthauser. Electrical Engineering, Faculty Advisor: Rohit Dua

The team has opted to design and construct a control panel that interfaces with residential irrigation systems and lighting systems. The control interface will allow the customer to gain full authority over their sprinkler system and lighting system through an O.S. agnostic, browser-based solution. The control panel, which connects to the customer's home WIFI, will serve a webpage that gives the customer access to the controlled systems enabling them to change yard effects. The system will include timers to support scheduling for lighting and irrigation. LEDs and valves can be activated remotely through the web page with only one valve able to be active at a time to provide sufficient pressure to the system. Our demo system will consist of a white LED and two valves to showcase the system's control and timing capabilities.

#### **#40 - MAGNETIC LINEAR ACCELERATOR**

Jacob Adams, Cole Nichols, Hayden Windmiller. Electrical Engineering, Faculty Advisor: Douglas Carroll

In this study, we present a magnetic linear accelerator (MLA) designed and constructed using an 18V Milwaukee Battery as the power supply, resin printed barrel design, and an optical trigger to control the coils. The MLA consisted of two stages for enhanced acceleration. The barrel of the MLA was designed using a resin printer to achieve precise dimensions and smooth surfaces. The coils were wound around the barrel, and an optical trigger was used to turn them on and off for precise control of acceleration. The 18V Milwaukee Battery then connects to the coils. The MLA successfully accelerated projectiles along the barrel, achieving significant speeds. The two-stage design allowed for increased acceleration compared to a single-stage MLA. The use of an 18V Milwaukee Battery as the power supply provided adequate power for the MLA, and the resin printer allowed for precise and smooth barrel design. The optical trigger enabled precise control of the coils, resulting in efficient acceleration. Overall, our results demonstrate the successful construction and operation of a magnetic linear accelerator using readily available components and 3D printing technology.

#### **#41 - THE EFFECT OF TEMPERATURE ON ELECTROCHEMICAL REDUCTION OF CARBON DIOXIDE AND FORMATE PRODUCTION**

Joshua Cox, Missouri State University. Co-Authors: Dr. Daniel Moreno, Missouri State University. Faculty Advisor: Daniel Moreno

From continued use of fossil fuels for energy and transportation, the amount of CO<sub>2</sub> in the atmosphere continues to increase hence contributes to climate change. Electrochemical CO<sub>2</sub> reduction (CO<sub>2</sub>RR) is a method of extracting CO<sub>2</sub> from the atmosphere and converting it into useful fuels. One such fuel is formic acid, which has applications as fertilizer and for hydrogen storage. Electrochemically, formic acid is produced in solution as formate, upon the reaction of CO<sub>2</sub> with H<sup>+</sup> protons in solution. In this work, an H-Cell apparatus used for reduction reactions was used alongside Tin electrodes for selectivity of formic acid production. Cyclic Voltammetry (CV) was done using a potentiostat to find the ideal voltage to optimize reduction current, and the effects of temperature on peak reduction current was studied at various scan rates. Initial formic acid production experiments were also ran using an ideal voltage (3 V total) at room temperature. Formate samples have been collected and will later be analyzed using analytical techniques such as UV-vis spectroscopy and ion chromatography.

#### **#42 - THE EFFECT OF DIFFERENT TYPES OF CHARGING CYCLES AND COMPOSITION ON THE AGING OF LI-ION BATTERIES FOR ELECTRIC VEHICLES**

Ana Torres Ladino, Missouri State University Co-Authors: Dr. Daniel Moreno, Missouri State University, Dr. Tayo Obafemi-Ajayi, Missouri State University. Faculty Advisor: Daniel Moreno  
Lithium-ion batteries (LiBs) are often recommended for electric vehicles (EVs) use due to their high capacity, high power, and longer lifespan compared to other battery chemistries. Understanding aging for LiBs is crucial for optimizing the battery operation in real-life applications. Factors such as temperature, size, chemical composition, voltage cutoff, and depth of discharge affect the performance of the cells. In this work, the focus is on different cycling loads to determine differences in aging effects that are meant for EVs. Electrode porosities are also calculated to determine the extent to which battery materials were coated onto the current collector. In addition, this research shows how different compositions influence the charging as well as aging of these LiBs by the current, voltage, and running time of the cycle. The studies are coupled with electrochemical impedance spectroscopy (EIS) testing, to incorporate the physical mechanisms of aging into a circuit model which predicts aging subject to different loads over larger numbers of cycles. The different techniques used for investigating battery aging offer valuable results that will be used to enhance the efficiency of LiBs. Furthermore, future investigations with this research will focus on analyzing the correlation between porosity and resistance changes.

### **#43 - HEAVY METAL CONTENT OF NATIVE PLANTS IN TRI -STATE MINING DISTRICT TO EVALUATE USE IN PHYTOREMEDIATION**

Elizabeth Jones. Geology, Geography, and Planning. Advisor: Mélida Gutiérrez

Mining activity within the Tri-State Mining District ended in 1970, but the remaining mining waste still impacts the health of wildlife. In this study, two native species, Northern Sea Oats and Giant Ragweed, were collected from two different locations on the bank of Center Creek. The lead, zinc, and cadmium content of these plants were analyzed for the above and below parts, and these were compared to the metal content of soils in which they were growing. The results determine their potential for phytoremediation. Phytoremediation is a method of cleaning contaminated soil using plants. The County Road 130 had more metals in the soil than the Stones Corner Access location and this was reflected in the plants. Giant Ragweed accumulated more zinc and cadmium than Northern Sea oats, which accumulated more lead.

### **#44 – WATER QUALITY OF URBAN SPRINGS IN SPRINGFIELD, MO: DATA REVISITED**

Megan Jones. Geology. Faculty Advisor: Mélida Gutiérrez

Maintaining data, current data, about all our natural resources is important to protect ecosystems, natural and urban life alike. The city of Springfield, MO largely sources freshwater from surface and groundwater sources like McDaniel and Fulbright Spring. Due to climate change and the increasing amount of human activity in the Springfield area, changes in groundwater behavior could happen suddenly. Keeping relevant data about spring and groundwater quality is important to anticipate and prevent potential deterioration of aquifer quality. The first focus of this project was reviewing available general data and water quality data of springs located in urban Springfield, MO. All data reviewed was sourced from publicly accessible resources, largely the Missouri Department of Natural Resources (MDNR). Results yielded 150 spring locations with varying amounts of data. The second focus of this project was contributing to this data by conducting our own water quality research. Four springs were selected in this area to conduct testing on: Silver Spring, Sequiota Spring, Doling Spring, and Dingledein Spring. At these sites, samples were tested for pH, nitrates, turbidity, and total hardness. Analysis yielded relatively stable water quality results.

### **#45 – SEQUIOTA CAVE SPRING AND POND INFLUENCE ON WATER QUALITY IN GALLOWAY BRANCH, SE SPRINGFIELD, MO**

Oluchi Nweke. Geography, Geology and Planning. Advisors: Hannah Bieser (OEWRI Research Assistant) & Dr. Bob Pavlowsky

Water quality problems are a growing concern in urbanizing watersheds. Further, karst geology can increase contamination risk since nonpoint pollutants may be collected from a wide area by sinkholes and fractures for localized release at a spring outlet. This study monitored baseflow at Sequiota Spring and Galloway Branch in Springfield, Missouri from September 2022 to March 2023 for discharge, sediment, chloride, bacteria, and nutrients. Sequiota Spring has had water quality concerns since the 1970's, and more recently due to bacteria from aging domestic sewer systems. The objectives of this study were to assess contamination levels and evaluate the influence of a pond below the spring on water quality in downstream Galloway Branch. The pond helped to reduce the concentrations of E. coli bacteria, total phosphorus, and total nitrogen. However, little effect was observed on chloride, dissolved solids, and possibly very fine particulate concentrations suggesting less pond influence on dissolved constituents compared to biologically active or sediment-absorbed pollutants. The results of this study add to our understanding of water quality problems in Galloway Branch and can help to evaluate the effects of recent land use and sewer infrastructure improvements on pollutant reductions in Sequiota Spring.

#### **#46 - CAN BOOKS BE TOXIC? AN XRF ANALYSIS OF ARSENIC CONTENT IN BOOK COVERS FROM MEYER LIBRARY SPECIAL COLLECTIONS**

Abby Momberg. Department of Geology, Geography, and Planning. Faculty Advisor: Dr. Douglas Gouzie

Recent studies have found that some books have arsenic in their covers and Missouri State Universities, Meyer Library, Special Collections department was curious if some of their own books may also contain arsenic. We are testing to see if there is any arsenic in the fabric that was used to cover the books. We are specifically looking at books that were covered in fabric that is a green or otherwise known as a “Paris Green” color. The arsenic was used to get the bright green color and was used in carpeting, wallpaper, book covers and more. A handheld XRF was used to test small spots on the covers and this allowed us to see what elements are present. This research could change the way that these books are stored to make it safer for the librarians handling them. We are still testing more books and our findings could change but so far it seems that books that were produced in the early 1800’s until the early 1900’s have on average a higher arsenic content within their covers

#### **#47 - WHO WELCOMES REFUGEES? REFUGEE RESETTLEMENT AGENCIES AND THIRD SECTOR ORGANIZATIONS IN THE SOUTHEASTERN U.S.**

Genevieve Stark and Katherine Rudolph. Geography, Faculty Advisor: Dr. Emily Frazier  
Since 1980, the United States has resettled more than 3 million refugees through the U.S. Resettlement and Placement Program (USRAP). Through this program, federally funded Resettlement Agencies (RAs) provide services to refugees upon arrival, such as employment assistance, housing, and language training, in order to support integration into U.S. society. Most refugees only receive these government-funded services for 90 days after arrival, yet the challenges of integration persist longer than this initial period. In the U.S., non-governmental Refugee Third Sector Organizations (RTSOs) “fill the gaps” for newly resettled refugees by providing arrival, transitional, and post-resettlement assistance beyond the scope of USRAP-funded priorities. RTSOs provide important support for refugees and facilitate better long-term integration outcomes, yet little is known about the distribution, affiliations and services offered by these organizations in the U.S. context. Drawing on publicly available data about resettlement services provided by resettlement agencies and RTSOs in ten states across the U.S. southeast, this study analyzes resettlement assistance offered by RTSOs beyond the USRAP. Findings indicate a shift in the landscape of welcome across the southeastern U.S., as services provided by minority faith-based groups reflect a vision of more holistic and equitable integration.

#### **#48 - BEACH EROSION TRENDS AT CRAB POND POINT SEA TURTLE NESTING SITE, SOUTHWEST COAST, JAMAICA.**

Allison Gargus, Geography. Advisors: Hannah Lowery, RA OEWRI, & Dr. Bob Pavlowsky.  
Global sea level rise is increasing beach erosion rates that threaten sea turtle nesting areas. There are major concerns about the conservation of sea turtles and nesting habitat in the Caribbean. This study assesses the habitat conditions and changes in the location of shoreline vegetation and beach width in a turtle nesting area at Crab Pond Point along the coast of Jamaica. Beach and vegetation locations along 425m of shoreline were compared between 2001 and 2022 using Google satellite images and GIS analysis. The impacts of Hurricane Ivan in 2004 were measurable but not as some later disturbances. Substrates were assessed at 25m intervals and varied from sand (57%), gravel and cobble (41%), and rock/reef (2%) with sand beach face widths of 2-40m. Periodic storms cause landward shifts in sand beaches from 0-24m, but recovery does generally occur. However, since 2001, sand beaches have eroded landward by about 0-8m. Storm waves removed 0-62m of shrubs and small trees since 2001. However, recent land-clearing for potential development purposes presents the most immediate threat to the stability and protection of this nesting area.

## **#49-IMPROVED WATER ACCESS USING A RAINWATER CATCHMENT SYSTEM ON THE SOUTHWEST COAST OF JAMAICA**

Valerie Holcomb, Geography. Advisor: Bob Pavlowsky, GGP/OEWRI

Community access to drinking water is often limited in rural Jamaica. Water cannot be pumped up into the mountains since spring sources are at lower elevations. Further, some neighborhoods are located far away from public water, or the supply lines have been damaged. To help illustrate one solution, we document the installation of a roof-top catchment system on a house in Belmont, Jamaica. Students from Missouri State University collaborated with Jahworks, Inc., a nonprofit group, and Jamaican supervisors to install the system in March 2023. Since the program began in 2016, 80 systems have been installed. The system collects rain off the roof, filters out particulates, and directs flow into a large tank with a faucet for use. Local families benefit greatly by having on-site water. Compared to carting water long distances, it frees up more time for employment and family activities. Installation events and the added water brings the community together. However, there are limitations to funding and systems are typically targeted for houses only of a specific design. More planning is needed to better understand the geography of water accessibility and plan how to deliver drinking water to the entire community.

## **#50 - DESTINATION IMAGE OF KANSAS CITY FROM THE PERSPECTIVE OF GENERATION Z**

Alyson Morgans, Jake Boaz, Madison Smith, Dodge Schapeler. Hospitality Leadership. Faculty Advisor: Dr. Nancy Kageyama

The destination image of a place is how visitors tend to see or perceive a particular destination. With our study, we are looking into the destination image of Kansas City. For our research we are focusing on collecting primary data through a survey with both qualitative and quantitative information via the online forum Google Forms. Our target age range will be 18-24 with all genders who study at Missouri State University. There will be 20 questions, 8 qualitative and 12 being quantitative to gauge the average person's opinion of Kansas City. The results indicated that Kansas City could benefit from making their social media presence and advertising strategies stronger and could even have residents participate in this process. Cleanliness, crime rate, and traffic were also a concern among visitors and felt Kansas City should take initiative to solve these issues to better tourists' opinions of the City.

## **#51 - DEVELOPING FRACTION-AS-MEASURE CONCEPTIONS TO SUPPORT GROWTH IN STUDENTS' ALGEBRAIC REASONING CAPACITIES IN MATH 101.**

Grace Herbold and Jake Gabbert. Mathematics. Faculty Advisor: Patrick Sullivan

Students (n= 117) enrolled in Intermediate Algebra courses (MATH 101) at MSU participated in a pre-assessment (15-question, multiple-choice) to understand the nature of their current numerical reasoning capacities. On one contextual problem approximately 30% of students reasoned that  $\frac{5}{6}$  and  $\frac{7}{8}$  were "equal to each other." On two other problems involving addition of fractions a significant percentage of students simply added the numerators and denominators to determine the answer. These responses suggest a part-whole conception of fractions meaning they attend to only the quantity of parts and the whole (e.g., "five sixths and seven eighths are equal because both are one away from the whole"). Students with this conception merely identify either the "gap" between the part and whole to compare fractions or combine quantities representing the part and the whole. An intervention was introduced to develop fraction-as-measure conceptions. This conception is consistent with how whole numbers are interpreted and aligns with how most operations involving fractions are interpreted (i.e., addition, subtraction, and division). Analysis of post-assessment results indicate that students' fraction-as-measure conceptions have developed, and those same students show advancement in mathematical reasoning capacities. Results also show how limiting a dominating part-whole conception is for students.

## **#52- IMPLEMENTATION OF A HOUGH TRANSFORM ON A FIELD PROGRAMMABLE GATE ARRAY**

Matthew Bruenning, Physics, Astronomy and Materials Science. Faculty Advisor: Tiglet Besara  
This presentation describes the process of studying a Hough Transform's timing capabilities and resource utilization when implemented on a Field Programmable Gate Array, in an effort to move neural network offline computations closer to the readout electronics of the detectors for high energy particle detectors. A Hough Transform is used as a method for calculating the equations of straight lines based on a 128x128 pixelated array. The Hough Transform, written in C, is exported as a Register-Transfer-Level project from Vitis High Level Synthesis, where pipelining can be used to optimize the clock frequency of the algorithm. Due to radiation damage or bit fails during data transmission, an acceptable track reconstruction algorithm needs to be accurate even when there are missing data points. By comparing the resource usage and clock frequency estimates to previous literature [1] and studying the accuracy/precision of the algorithm, it can be determined if this is a suitable track reconstruction algorithm for high energy physics experiments.

## **#53- INVESTIGATING OUTCOMES OF INNER PLANET FORMULATION INFLUENCED BY A JUPITER-LIKE PERTURBER**

Simarpreet Girn. Physics Astronomy/Material Sciences. Faculty Advisor: Dr. Sarah J. Morrison  
The most common planets within 1 AU of a star are a few Earth radii in size, dubbed 'super-Earths.' Yet the Solar system lacks a super-Earth, and potentially the presence of Jupiter played a role. For this project, the outcomes of in situ inner planet formation under the influence of a massive outer planet were analyzed. Ninety-two N-body dynamical simulations were conducted of the in-situ formation process with a Jupiter-mass planet at a distance of five astronomical units from a host star. These simulations were then compared with the same inner planet conditions without a massive outer planet. The simulations were conducted in two stages: 1) during the residual protoplanetary disk phase with damped orbit eccentricities and 2) post-disk dispersal with subsequent dynamical evolution. It was found that systems produced more planets at lower surface densities. The average mass and eccentricity in the cases with no Jupiter were higher in stage two compared to the massive planet present. There was a tendency for the average number of planets produced to be higher in simulations with Jupiter, especially at different solid surface density ranges.

## **#54 – ORBIT PERTURBATIONS TO HABITABLE ZONE PLANETS FROM MASSIVE PLANETS AT THE SNOWLINE AROUND M STARS AND G STARS**

Samuel Cope, Bishwash Devkota, Missouri State University, Faculty Advisor: Sarah J. Morrison  
Massive planets may preferentially form just outside the water ice snowline in protoplanetary disks, and how these massive planets would influence the orbits of Earth mass planets located in the habitable zone of Solar type (G) stars and M dwarfs is investigated. Dynamical simulations that tracked the orbit evolution of an Earth mass planet in the habitable zone and an outer massive planet placed at the system's primordial water ice snowline were performed. Cases with the Earth mass planet placed at different locations in the habitable zone and a Jupiter mass planet around G stars and with a Neptune mass planet around M stars were all considered. The magnitude and timescales of variation in the orbit of the habitable zone planet in each scenario from these simulations were then analyzed. The snowline is not as separated from the habitable zone around M dwarfs as for G stars, so planets in the habitable zone of M dwarf stars are generally more strongly perturbed than planets orbiting G stars. The eccentricity increased the lower mass the star. Orbit perturbations in context with the change in solar flux received by the habitable zone planet and implications for its climate will be discussed.

### **#55 - DEVELOPMENT OF ARTIFICIAL INTELLIGENCE-BASED FORCEFIELDS TO MODEL TUNNEL BARRIERS IN SUPERCONDUCTING QUBITS**

Rachel Lee. Career Prep Physics and General Mathematics. Faculty Advisor: Ridwan Sakidja  
This study is in developing the potential models to predict forces between atomic configurations of water and TMA (Tri-Methyl-Aluminum) using Artificial Intelligence. This study is done with the goal of developing an ultra-thin alumina layered less than 1 nanometer which is used in building a tunnel barrier of superconducting qubits. When water that delivers Oxygen and TMA that carries Aluminum are alternated during deposition, each layer should be as flat as possible to guarantee no leakage and full control over the quantum circuit. To assure high quality Alumina tunnel barrier, understanding the atomic interactions between water and TMA is crucial, which can be accurately done by using quantum mechanics. However, using quantum mechanics for thousands of atoms for such tunnel barrier is computationally costly, and this is why using AI can reduce the time and cost while guaranteeing the accuracy of quantum mechanics as well. Utilizing AI allows accurate yet effective computations of forces between water and TMA, which helps to design alumina tunnel barrier, the key building block of quantum computing.

### **#56 - FRACTAL ANALYSIS OF GRAVITATIONAL WAVES AND NOISE**

Yashasvi Moon, Physics, Astronomy & Materials Science, Marco Cavaglia, Missouri University of Science and Technology. Faculty Advisor: Robert Mayanovic

We present a new method, based on fractal analysis, to characterize the output of a physical detector that is in the form of a set of real-valued, discrete physical measurements. We apply the method to gravitational-wave data from the latest observing run of the Laser Interferometer Gravitational-wave Observatory. We show that a measure of the fractal dimension of the main detector output (strain channel) can be used to determine the instrument status, test data stationarity, and identify non-astrophysical excess noise in low latency.



# BIOLOGY

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

## CURRENT RESEARCH

- **Giorgia Auteri** - Population Genetics, Conservation, Bats
- **Paul Durham** – Cell Biology, Neurobiology
- **Debra Finn** – Stream Ecology
- **Brian Greene** – Herpetology, Ecology
- **Kyoungtae Kim** – Cell Biology, Molecular Genetics
- **La Toya Kissoon-Charles** – Wetland Ecology, Wetland Plants
- **Laszlo Kovacs** – Genetics, Grapevine Biology
- **Day Ligon** – Physiology, Herpetology
- **Christopher Lupfer** - Microbiology, Immunology
- **Sean Maher** - Mammalogy, Ecology
- **Alicia Mathis** – Behavioral Ecology, Herpetology
- **Jay McEntee** – Evolution of Bird song
- **Babur Mirza** - Environmental Metagenomics, Microbial Ecology, Bioremediation
- **Quinton Phelps** – Applied Fisheries management
- **Avery Russell** – Plant-insect interactions
- **Georgianna Saunders** – Biology Education
- **Charles Stephen** - Cave insects
- **Alexander Wait** – Plant Ecology, Conservation

# CHEMISTRY & BIOCHEMISTRY

The Department of Chemistry & Biochemistry at Missouri State University has 17 tenured/tenure-track faculty, 2 instructors, 3 staff members, 21 graduate students, and 150 majors. The Department has maintained programs approved by the American Chemical Society Committee on Professional Training since 1974 and offers tracks designed to help students achieve successes in a variety of career directions, including graduate school, industrial applications, medical school, biotechnology, materials development, and environmental engineering. The primary goal of the department is to produce graduates with a sound background in the fundamental areas of chemistry and a working knowledge of modern instrumentation. Toward this end, all chemistry majors have the opportunity to experience hands-on training with a broad range of instruments in their course work, and all majors participate in undergraduate research, which offers opportunity for real-world application of coursework knowledge and helps to develop critical thinking skills.

## CURRENT RESEARCH

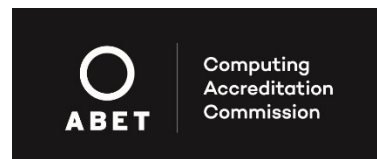
- **Tuhina Banerjee** - Biochemical, Biophysical and Nanotechnology
- **Gautam Bhattacharyya** - Chemical Education Research
- **Richard N. Biagioni** - Analytical and Environmental
- **Eric Bosch** - Organic Chemistry, Crystal Engineering and Coordination Chemistry
- **Bryan E. Breyfogle** - Electrochemistry of Materials; Chemical Education
- **Natasha DeVore** – Biochemistry and Structural Biology
- **Nikolay Gerasimchuk** - Inorganic/Bioinorganic Chemistry - Oxime-Bearing Ligands and Their Metal Complexes; physical methods of investigations of chemical compounds; x-ray crystallography
- **Gary A. J. Meints** - Physical/Biophysical Chemistry, NMR Spectroscopy of Damaged DNA
- **Mark M. Richter** - Analytical - Photoluminescence and Electrogenerated Chemiluminescence (ECL)
- **Cyren Rico** – Analytical, Environmental, Nanomaterials-Plant Interactions, Ecological Effects of Nanomaterials
- **Alan Schick** - Physical/Materials Chemistry - Colloid and Surface Chemistry; Organic films and emulsions
- **Reza Sedaghat-Herati** - Organic and Polymer Chemistry
- **Matthew Siebert** – Theoretical organic and organometallic chemistry
- **Erich D. Steinle** – Analytical, Developing Sensors Based on Nanotechnology and Electrochemistry
- **Adam K. Wanekaya** - Analytical Chemistry, Nanomaterials in Sensing, Biological and environmental applications
- **Fei Wang** – Inorganic/Physical Chemistry; high-temperature solid state syntheses, X-ray crystallography, intermetallic compounds, thermoelectric materials, first-principle band structure computation
- **Keiichi Yoshimatsu** - Biosensing, Fluorescent Sensing, Paper-based Analytical Device, Protein and Peptide Science, Polymer Chemistry

# COMPUTER SCIENCE

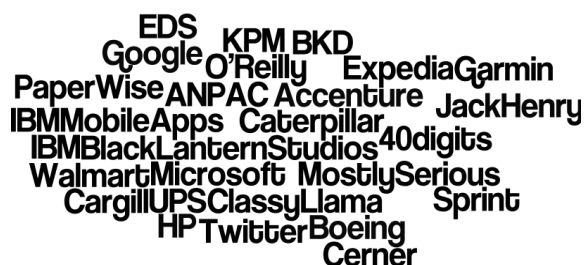
Computer science is a technology-oriented discipline whose fundamental principles combine theory, abstraction, and design. A solid foundation in the fundamental principles is critical to continued learning and adaptation to the technological changes which occur so rapidly in this discipline. The department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

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

MSU's Computer Science program has for many years been accredited by the Computing Accreditation Commission of ABET, [www.abet.org](http://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](http://careercenter.missouristate.edu)), and average starting salaries for 2016 CS grads are projected at \$61,321. (See [www.nacweb.org](http://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
- **Mukulika Ghosh** – Robotics, Computation Geometry, Solid and Physis based Modeling, Algorithms
- **Razib Iqbal** – Multimedia Systems and Communications, Digital Content Adaptation, Software Engineering, Software Quality Assurance, Automated Software Verification and Validation, Internet of Things, Computer Security.
- **Ajay Katangur** - Cyber Security, Information Assurance, Cloud Computing, Wireless Networks, Computer Networks, Optical Networks, Mobile Computing
- **Anita Liu** – Wireless Ad-hoc, Sensor Networks, Mobile Computing, Parallel and Distributed Computing, and Bioinformatics
- **Siming Liu** - Search, Optimization, Machine Learning, Evolutionary Computation, Artificial Intelligence, Parallel and Distributed Computing, Games and Simulations
- **Jamil Saquer** – Data Mining, Formal Concept Analysis, Machine Learning, Computer Science Education, Graph Theory and Graph Algorithms
- **Lloyd Smith** – Multimedia Digital Libraries, Speech-driven and Multimodal User Interfaces, Music Information Retrieval, Computer-aided Music Education, Pattern Recognition

# COOPERATIVE ENGINEERING PROGRAM

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

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

## CURRENT FACULTY

- **Dr. Douglas Carroll** – PhD, Missouri University of Science and Technology
- **Dr. Abdulaziz Abutunis** - PhD, Missouri University of Science and Technology
- **Dr. Rohit Dua** – PhD, Missouri University of Science and Technology
- **Dr. Kelvin Erickson** – PhD, Iowa State University
- **Dr. Ryan Hutcheson** – PhD, Texas A&M University
- **Dr. Daniel Moreno** – PhD, Georgia Institute of Technology
- **Dr. Tayo Obafemi-Ajayi** – PhD, Illinois Institute of Technology
- **Dr. Theresa Odun-Ayo** – PhD, Missouri University of Science and Technology
- **Dr. Matthew Pierson** – PhD, University of Kansas
- **Dr. Sanjay Tewari** – PhD, Texas A&M University
- **Dr. Jeffrey Thomas** – PhD, Missouri University of Science and Technology

# GEOLOGY, GEOGRAPHY & PLANNING

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

## CURRENT RESEARCH

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

# HOSPITALITY LEADERSHIP

The Department of Hospitality Leadership prepares students for managerial positions in hotels, restaurants, resorts, casinos, institutional foodservice, special events, catering, and many other areas. Students in the major choose to pursue one or more of the following options: Lodging, Food and Beverage, Senior Living, Club Management, Tourism, and General Operations.

The department boasts two active student organizations, opportunities for experiential learning, access to many industry professionals, and an active advisory board. A dedicated Hospitality Career Fair is held every March and October, enabling students to obtain positions with leading regional and national hospitality firms.

The HL faculty is comprised of a group of individuals with numerous publications and presentations who hold leadership posts in various international, regional, and local associations and organizations. They have won many teaching and service awards, and are highly regarded for their dedication and commitment to hospitality education.

The Hospitality Leadership department is accredited by the Accreditation Commission for Programs in Hospitality Administration (ACPHA). It has been continuously accredited since 1992.

## **Mission of the Hospitality Leadership Department**

The Department of Hospitality Leadership at Missouri State University is committed to creating an environment of academic excellence. We prepare our students to be ethical leaders in the hospitality and tourism industries by providing an environment where meaningful learning and development is a priority. We serve our constituencies through quality teaching, community engagement, and relevant focused research.

## **CURRENT FULL-TIME FACULTY**

- **Albert Barreda**, PhD – University of Central Florida
- **Matt Bekebrede**, BS – Missouri State University
- **Liza Cobos**, PhD - University of Central Florida
- **Yoshimasa ‘Nancy’ Kageyama**, PhD – University of Central Florida
- **Wajeana White**, MPS – Missouri State University
- **Kara Wolfe**, PhD – Kansas State University

# MATHEMATICS

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

## CURRENT RESEARCH

**Richard Belshoff** - Commutative Rings and Algebras and Associative Rings and Algebras

**William O. Bray** - Harmonic Analysis

**Yue Cui** – Statistics, Nonparametric models

**Ngoc Do** – Inverse problems, Spectral theory

**Adam Harbaugh** - Mathematics Education

**Shouchuan Hu** - Nonlinear Functional Analysis and Multivalued Analysis, Differential Equations

**Kurt Killion** - Curriculum Development for Preservice Elementary and Middle School Mathematics Teachers

**Shelby Kilmer** – Topology, Abstract Harmonic Analysis, Approximation Theory

**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

**Xingping Sun** – Applied Mathematics, Approximation Theory, Computational Analysis, Numerical Analysis

**Cameron Wickham** - Commutative Algebra, Finite Rings, Homological Algebra.

**Matthew Wright** – Harmonic Analysis and Partial Differential Equations

**Songfeng Zheng** – Pattern Recognition and Machine Learning, Statistics Applications, Image Analysis and Statistical Learning Theory

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

**Joann Barnett**

**Patti Blanton**

**Roger Bunn**

**Oana Nelson**

**Carolyn Shand-Hawkins**

**Donna Sherrill**

**Gary Stafford**

**Linda Sun**

**Kimberly Van Ornum**

**Fan Zhou**

# PHYSICS, ASTRONOMY & MATERIALS SCIENCE

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

## CURRENT RESEARCH

- **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
- **Sarah Morrison** - Orbital Dynamics and Evolution of Extrasolar Planetary Systems
- **Emmett Redd** – Optical Neural Networks
- **Michael Reed** - Asteroseismology of late evolution compact pulsating stars
- **Ridwan Sakidja** – Computational Materials Science, High Temperature Materials, Protective Coatings, Materials Genome



# 2022 CNAS Undergraduate Research Symposium Winners

## **Biology: Ecology, Wildlife and Conservation**

**1st Place:** *Courtney Duncan*

CARBARYL SENSITIVITY IN GRAPEVINE

Faculty Advisor: Dr. Laszlo Kovacs

**2nd Place:** *Malachai Frisby, Daphne Miles*

METAL CONTAMINATION DECREASES MACROINVERTEBRATE ABUNDANCE IN BIG RIVER OF SOUTHEAST MISSOURI

Faculty Advisor: Dr. La Toya Kissoon-Charles

## **Biology: Cellular, Microbiology and Genetics**

**1st Place:** *Seth Harris*

ML-1 THYROID CANCER CELLS ARE MORE RESISTANT TO PLATINUM-BASED CHEMOTHERAPEUTIC AGENTS

Faculty Advisor: Dr. Kyoungtae Kim

**2nd Place:** *Tarkesia Blakley*

THE EFFECTS OF HYPOCHLOROUS ACID AGAINST INFECTIOUS MICROBES

Faculty Advisor: Dr. Chris Lupfer

## **Chemistry and Biochemistry**

**1st Place:** *Krusha Bhakta*

BIOPHYSICAL STUDIES OF DNA BACKBONE INTERCONVERSION AND DYNAMIC PROPERTIES VIA NMR

Faculty Advisor: Dr. Gary Meints

**2nd Place:** *Cassidy Soard*

SENSITIVE DETECTION OF EBOLA VIRUS USING FUNCTIONAL NANOSENSOR

Faculty Advisors: Dr. Tuhina Banerjee

## **Computer Science**

**1st Place:** *Selma Bouraoui*

DETECTION OF MALICIOUS CONTENT IN COMPRESSED FILES USING DEEP CONVOLUTIONAL NEURAL NETWORKS

Faculty Advisor: Dr. Mohammed Y, Belkhouche

**2nd Place:** *Hung Nguyen*

AUTONOMOUS CONTROL OF FIXED-WING AIRCRAFT USING DEEP REINFORCEMENT LEARNING

Faculty Advisors: Dr. Siming Liu

## **Cooperative Engineering**

**1st Place:** *Matt Bowie, Jeremy Long, Bronson Tavenner, Aaron Ivie*  
AUTOMATED SOLAR TRACKING SYSTEM  
Faculty advisors: Dr. Tayo Obafemi-Ajayi

**2nd Place:** *Grant Shaver, Austin Atkins, Isaac Hargrave, Samuel Whittington*  
PID FLUID TEMPERATURE CONTROLLER  
Faculty Advisors: Dr. Tayo Obafemi-Ajayi

## **Geology**

**1st Place** *Ramona Gomez*  
WATER QUALITY MONITORING OF FIVE SPRINGS IN POLK COUNTY, MISSOURI, TO DETERMINE CONTAMINATION RISKS TO THE SPRINGFIELD AQUIFER  
Faculty advisor: Dr. Melida Gutierrez

**2nd Place:** *Dorian DeHart*  
BUILDING A RATING CURVE FOR STREAMS IN SPRINGFIELD, MISSOURI  
Faculty Advisors: Dr. Doug Gouzie

## **Geography, Geospatial and Planning**

**1st Place:** *Hannah Lowery, Allison Gargus*  
WATER QUALITY ANALYSIS IN BLUEFIELDS BAY, JAMAICA DURING MARCH 2022  
Faculty advisor: Dr. Robert Pavlowsky

**2nd Place:** *CJ Moore, Gavin Moore, Dylan Berndt*  
DATA COLLECTION INFRASTRUCTURE FOR FEATURE SIMILARITY ANALYSIS IN SATELLITE IMAGES OF ARCTIC SEA ICE  
Faculty Advisors: Dr. Xin Miao

## **Physics, Astronomy and Materials Science**

**1st Place:** *Cory Padgett*  
ESTIMATING THE DEGREE OF ATMOSPHERIC JEANS ESCAPE FROM TERRESTRIAL EXOMOONS  
Faculty Advisor: Dr. Sarah Morrison

**2nd Place (tie):** *Jessica Fink*  
FABRICATION OF 2D HETEROSTRUCTURE OF GRAPHENE AND TRANSITION METAL OXIDES  
Faculty Advisor: Dr. Kartik Ghosh

**2nd Place (tie):** *Amira Bezine*  
THE ORBITAL DRIFT OF CRYOVOLCANIC MATERIAL FROM ENCELADUS WITHIN SATURN'S E RING  
Faculty Advisor: Dr. Sarah Morrison

<b>CNAS SCHOLARSHIPS,</b> <a href="https://science.missouristate.edu/Scholarships.htm">https://science.missouristate.edu/Scholarships.htm</a>	<b>SCHOLARSHIP DESCRIPTION</b>
<b>1st Lieutenant Gary Finley Engineering Scholarship</b>	<p>The Recipient of this award will be an undergraduate student properly enrolled full time at Missouri State University pursuing a career in engineering. When awarded to an incoming freshman, consideration will be given to high school performance, college potential, and leadership qualities. When awarded to a student enrolled at the sophomore level or higher the student must have maintained an overall grade point average of at least 3.2. Preference shall be given to a student enrolled in and/or participating in the Military Science/ROTC program. The student will hold the scholarship for one academic year. The scholarship may be renewed but students must reapply and be considered with all other applicants</p>
<b>Amelia Counts Scholarship</b>	<p>The recipient of this scholarship will be an incoming or current undergraduate student enrolled full time at Missouri State University pursuing a degree within the College of Natural and Applied Sciences. The recipient must have a cumulative GPA no less than 3.1. Preference will be given to students in the following order: 1. involved in a minimum of one (1) university student organization or athletic program or involved in two high school student organizations if an incoming freshman. 2. be a first-generation higher education student 3. resides in campus housing if a freshman or sophomore. The student can continue to hold the scholarship so long as they continue to meet the main criteria and the first preference. The student may hold the scholarship up to 4 academic years.</p>
<b>Andereck Family Scholarship</b>	<p>Awarded to incoming freshmen or undergraduate students properly enrolled at MSU and majoring (or with an interest in majoring) in Physics, Physics Education, Engineering Physics or Astronomy. This scholarship is renewable, but the student must reapply.</p>
<b>Banks Family Scholarship</b>	<p>Awarded annually to a full-time undergraduate majoring in the Department of Physics, Astronomy, and Materials Sciences. For incoming freshmen consideration will be given to high school academic performance and leadership. For sophomores or greater student must have overall GPA of 3.0 and a departmental GPA of 3.0. This scholarship is renewable, but the student must reapply.</p>
<b>Barbara J. Lucks Scholarship for a Sustainable Future</b>	<p>The Recipient of this award will be a First Generation junior, senior or graduate student in Geology, Geography and Planning (GGP) with a declared major of Geography and Sustainability, with a cumulative GPA of 2.5. Preference will be given to a student from a rural area. Applicant to complete an essay explaining your commitment to environmental sustainability, including how you plan to include environmental sustainability within your career objectives and personal life. This scholarship will be renewed automatically as long as the student continues to meet all criteria.</p>

<p><b>Bears CNAS Endowed Scholarship</b></p>	<p>The recipient of these awards will be an undergraduate or graduate student properly enrolled full-time at Missouri State University. Recipients will be a junior, senior or graduate student pursuing a degree in the College of Natural and Applied Sciences. Students must have a cumulative GPA of 2.8 or higher to qualify. Preference shall be given to a student demonstrating financial need. The student(s) will hold the scholarship for one academic year. This scholarship may be renewed, but student(s) must reapply.</p>
<p><b>Bill and Maret Cheek Scholarship</b></p>	<p>Awarded annually to a full-time undergraduate sophomore or greater majoring in Geography or Planning, with preference going to Planning students. Student must have an overall GPA of 3.0 and a departmental GPA of 3.25. Preference also given to students involved in professional organizations. All else equal, financial need may be considered. This scholarship is renewable, but the student must reapply.</p>
<p><b>Biology Alumni Scholarship</b></p>	<p>Awarded to a Biology major that has completed 60 hours toward a BA or BS degree in Biology and at least 15 hours of Biology (including BIO 235) with a minimum 3.0 GPA in Biology and must enroll for at least 12 hours. This scholarship is renewable, but the student must reapply for consideration with all other applicants.</p>
<p><b>Biology Board of Advisors Summer Research Fellowship</b></p>	<p>Awarded annually to a rising junior, senior or graduate student seeking a degree in the Department of Biology. The student must demonstrate an interest in pursuing graduate studies. Student will receive award in the summer semester, so they must be enrolled in at least 1 summer credit hour. This award may be renewed, but the student must reapply.</p>
<p><b>Biology Education Scholarship</b></p>	<p>Student must have completed 60 hours, with at least 15 hours of Biology (including BIO 235) with a minimum 3.0 GPA in Biology. The student must have been admitted into Teacher Education program with the intention to teach and be enrolled full-time. This scholarship is renewable, but the student must reapply.</p>
<p><b>Bob and Amy Schellhorn Geoscience Scholarship</b></p>	<p>The Recipient of this award will be an undergraduate student properly enrolled at Missouri State University. Recipients will be sophomore, junior or senior pursuing a degree in Geology. The student must have successfully completed GLG 332 (Mineralogy). Students must have a cumulative GPA of 2.5 or higher and a minimum of 2.8 GPA in Geology coursework. The recipient will hold the scholarship for one academic year. The scholarship is eligible for renewal, but the recipient must reapply and continue to meet the eligibility requirements.</p>
<p><b>Boeing Software Engineering Scholarship</b></p>	<p>Awarded annually to a full-time student majoring in Computer Science. Sophomores or greater must have an overall and departmental GPA of 3.2. Must be member of Missouri State University Chapter of Association of</p>

	Computing Machinery. Preference given to United States Citizens. This scholarship is not renewable.
<b>Bonnalie Oetting Campbell Biology Scholarship</b>	The recipient will be an undergraduate student properly enrolled at Missouri State University and majoring in Biology. The recipient will have a minimum overall GPA of 3.5. Preference will be given to those with financial need. The recipient must have completed or be currently enrolled in cellular biology or physiology. The award is automatically renewable as long as the recipient continues to meet the requirements of the award.
<b>Bonnalie Oetting Campbell Summer Research Award</b>	The recipient will be an undergraduate or graduate student properly enrolled at Missouri State University, majoring in Biology, and enrolled to perform summer field study work at the Bull Shoals Field Station. Students must be enrolled in at least one hour over the summer to receive aid in the summer semester. The award is renewable, but the student must reapply each year.
<b>C. Louis and Thelma Ferrell Van Buren Scholarship</b>	Awarded annually to a full-time junior or greater enrolled in College of Natural and Applied Sciences with an overall GPA of 3.0. Awards will be made with regard to financial need and consideration given to students involved in extracurricular activities. Students may be considered for renewal of the scholarship, but they must reapply with other candidates and continue to meet all criteria.
<b>Carla Hinton Memorial Biology Scholarship</b>	Awarded annually to a full-time student majoring in Biology. Sophomores or greater must have a 3.0 GPA in coursework in Biology. Awards will be made with regard for financial need. This scholarship may be renewed, but the student must reapply.
<b>Carol L. (Harless) Stephens Scholarship for Math Teachers</b>	Awarded annually to a full-time junior or greater working towards a BSED in Mathematics with a cumulative and departmental GPA of 3.0. Preference will go to students from Southwest Missouri. Awards will be made with regard for financial need. Scholarship will be automatically renewed as long as the student maintains satisfactory academic progress and continues to meet all scholarship requirements.
<b>Charles and Cindy Rodgers Scholarship</b>	The Recipient of this award will be a current undergraduate student or incoming freshman properly enrolled full-time at Missouri State University and is a resident of the state of Missouri. The Recipient must show financial need and have declared a major within the College of Natural and Applied Sciences. The Recipient must have a cumulative GPA of 3.2 if an existing undergraduate student or a high school cumulative GPA of 3.5 if an incoming freshman. The student will hold the scholarship for one academic year. The scholarship may be renewed, but the student may reapply and be considered with all other applicants.
<b>Chemistry Department Scholarship Fund</b>	Awarded annually to Chemistry major. Must be full-time with 75 or more credit hours earned as of the end of the academic year in which applying; Must have minimum GPA

	<p>of 3.0 in chemistry and overall, including transfer work, and a minimum of 19 hours completed in chemistry as of the end of semester in which applying; must be active in student organizations. This is a one-time award. Recipients may be considered for renewal with all other applicants.</p>
<p><b>Chemistry Department-Graduate Scholarships</b></p>	<p>Awarded annually to a student in their second, third, or fourth semester in the Chemistry graduate program with a GPA of 3.0. Must have made significant research progress towards thesis confirmed by Research Advisor. This is a one-time award.</p>
<p><b>Clyde and Judy Paul Mathematics Education Award</b></p>	<p>The Award will be given annually to a graduating senior pursuing a degree in a Mathematics program that will result in an initial Missouri certificate to teach mathematics at the high school level. The student must have completed all requirements for admission to and completion of the Teacher Education Program. Selection will be based on observed (by mathematics faculty) performance in the college classroom; field experiences as documented by mathematics faculty and other properly certified instructors; documented service activities; and personal characteristics favorable for teacher success that have demonstrated the recipient's potential to become an outstanding teacher. The recipient(s) must be a senior graduating at the end of the spring and/or summer semester that has completed a minimum of 60 hours, including a minimum of 15 hours of mathematics courses while enrolled at the Missouri State University Springfield campus. The recipient(s) must have completed at least one of the following courses: MTH 409 or MTH 410. This is a one-time award to be paid out the semester they are selected.</p>
<p><b>CNAS Scholarship for STEM Secondary Education Students</b></p>	<p>The recipient of this award will be a junior, senior, or graduate Science and/or Mathematics Secondary Education student within the College of Natural and Applied Sciences. Recipients must have a GPA that will lead toward certification in the State of Missouri. The scholarship shall be automatically renewable as long as criteria is still met. Those who receive the scholarship as juniors are eligible to reapply as a senior and those who receive as a senior are eligible to reapply as a graduate student.</p>
<p><b>College of Natural and Applied Sciences Scholarship</b></p>	<p>Awarded annually to a full-time undergraduate majoring in a program in College of Natural and Applied Sciences with an overall GPA of 3.0 and a departmental GPA of 3.5. Scholarship recipients may be considered for renewal of the scholarship but must reapply with all other applicants.</p>
<p><b>Computer Science Department Scholarships</b></p>	<p>There are currently no requirements for this scholarship other than being a student seeking a degree in the Computer Science Department. This scholarship is not renewable.</p>

<p><b>ConocoPhillips Scholarship for Computer Science</b></p>	<p>The Recipient of this award will be a full-time undergraduate student properly enrolled at Missouri State University seeking a degree within the Department of Computer Science and maintain a cumulative GPA of 3.0 or higher. This scholarship is intended to enhance diversity by encouraging students from diverse backgrounds to apply. Accordingly, recipients must have a demonstrated interest in and commitment to promoting an educational environment that is diverse and inclusive of individuals irrespective of their gender, race/ethnicity, veteran's status, disability, sexual orientation, and/or gender identity. Serious consideration will be given to all ways in which potential recipients might contribute to a diverse educational environment. Preference shall be given to a student who demonstrates financial need. This scholarship may be renewed, but the recipient must reapply for consideration with all other applicants.</p>
<p><b>D. Kent Smith Memorial Scholarship</b></p>	<p>Awarded annually to full-time junior or senior majoring in Geology with a minimum of 25 hours completed of required courses for Geology degree. Must have a GPA of 3.0 in these degree courses and overall. Preference given to students with no other scholarships. This scholarship is renewable, but the student must reapply.</p>
<p><b>Department of Chemistry Board of Advisors Summer Research Fellowship</b></p>	<p>Awarded annually to a rising junior, senior, or graduate student properly enrolled at Missouri State University within the Department of Chemistry participating in summer research. In addition, the student must possess a demonstrated interest in pursuing graduate studies in chemistry, be enrolled in at least one hour during the summer term and have a declared chemistry major. The student will hold the scholarship for one summer term. The award may be renewed, but student must reapply for consideration with all other applicants.</p>
<p><b>Doris C Lorz Scholarship Award</b></p>	<p>Awarded annually to a full-time junior or senior enrolled as a major in the Department of Chemistry that has completed 20 hours in Chemistry and has a departmental GPA of 3.8 and an overall GPA of 3.5. Preference will be given to those involved in extracurricular activities. The scholarship recipient may be considered for renewal but must reapply with all other applicants.</p>
<p><b>Dr. and Mrs. Thielmann Chemistry Education - Undergraduate Research Award</b></p>	<p>The Recipient(s) of this award will be an undergraduate student properly enrolled at Missouri State University. Up to two scholarships will be awarded to the top undergraduates pursuing a degree in chemistry education. Students must have completed at least 9 hours of chemistry coursework and have at least a 3.0 Cumulative GPA. The student will hold the scholarship for one academic year. The scholarship may be renewed but students must reapply and be considered with all other applicants.</p>
<p><b>Dr. Carl Fronabarger Family Memorial Scholarship</b></p>	<p>Awarded annually to a full-time student majoring in Mathematics and have a desire to pursue a career as a Math Teacher. Juniors or greater must have an overall GPA of 3.0 and a departmental GPA of 3.5. Students must have</p>

	financial need. Scholarship will be automatically renewed as long as the student maintains satisfactory academic progress.
<b>Dr. Carl Riegel Memorial Scholarship</b>	Awarded annually to a full-time undergraduate student seeking a degree in the Hospitality Leadership Department. Preference should be given to a veteran or the child of a veteran. This scholarship may be renewed, but the student must reapply.
<b>Dr. Eric Shade Memorial Scholarship</b>	The recipient of this award will be an undergraduate student properly enrolled as a Computer Science major at Missouri State University. Recipient must have an overall GPA great than or equal to 3.5. Recipient must have a membership in the Association for Computing Machinery. Preference should be given to a lower classman. Recipient must have been a member of the Association for Computing Machinery team the previous November. Should a team from Missouri State not have competed in the Association for Computing Machinery competition the previous November than scholarship selection committee may select a recipient meeting all other requirements who has shown interest in programming languages. The student will hold the scholarship for one academic year. The scholarship may be renewed, and preference is given to the student receiving the scholarship the previous year, but the student must reapply and continue to meet all criteria.
<b>Dr. John B. Prater Scholarship</b>	Awarded annually to full-time undergraduate students majoring in Mathematics or Computer Science that have completed or enrolled in the first calculus course. For freshmen consideration should be given to high school academic performance and leadership. Sophomores or greater must have maintained a high enough GPA to allow progress toward a degree. Awards will be made with a preference for financial need. Scholarship recipients may be considered for renewal of the scholarship but must reapply with all other applicants.
<b>Dr. John H. Keiser Endowed Scholarship in Public Affairs and Environmental Studies</b>	Awarded annually to a full-time student majoring in the College of Natural and Applied Sciences with an overall GPA of 3.25 and a GPA of 3.5 in their field of study. Student must be seeking a career related to the natural environment. Awarded based on financial need. Scholarship recipients may be considered for renewal of the scholarship but must reapply with all other applicants.
<b>Dr. Lonnie and Billie Scott Science and Mathematics Education Scholarship</b>	\$1,000 scholarship(s) will be awarded annually to an undergraduate student seeking a Bachelor of Science in Education (mathematics) or a pathway toward secondary education licensure for science education (BS + MAT) in the College of Natural and Applied Sciences. The recipient of the award should demonstrate excellence in academics while also being an active member of the community. Preference should be given to students graduating from Forsyth High School in Forsyth, MO. The student will hold the scholarship for one academic year. The scholarship may



	be renewed but students must reapply for full consideration with all other applicants.
<b>Dr. Robert W. Martin Research Fellowship</b>	Awarded annually to a full-time junior or senior majoring in the Chemistry Department with plans to pursue a graduate degree at Missouri State. Consideration given to academic performance and research interest. The recipient may be considered for renewal but must reapply with all other applicants.
<b>Dr. Roland Kimball Memorial Scholarship</b>	Awarded annually to a full-time junior or higher who is active in the Pre-Dental program. Student must demonstrate potential in the field of Dentistry as demonstrated through a letter of recommendation from a faculty member in CNAS. Student must have an overall GPA of 2.8 and demonstrate financial need. Scholarship recipients may be considered for renewal of the scholarship but must reapply with all other applicants.
<b>Dr. Tom Tomasi Biology Summer Research Award</b>	The Recipient of this award will be a senior student enrolled in the Accelerated Master of Biology tract or a graduate student in the Master of Biology program properly enrolled at Missouri State University. Preference will be given to students with financial need. Students receiving a faculty member's grant and/or holding a summer graduate assistantship within the Biology department at Missouri State University are not eligible. Students must provide a research plan and one letter of recommendation from their research mentor for consideration.
<b>Dr. Woodrow Sun Scholarship</b>	Awarded annually to a full-time undergraduate student majoring in Mathematics. For freshmen, consideration should be given to high school academic performance and leadership. Sophomores or greater must have an overall GPA of 3.0 and a departmental GPA of 3.0. Scholarship recipients may be considered for renewal, but they must reapply with all other applicants.
<b>E. Howard and Thelma F. Matthews Scholarship</b>	Awarded annually to a full-time sophomore or greater pursuing a B.S.ED. in Mathematics with an overall GPA of 2.5. Awarded with regard for financial need. Scholarship recipients may be considered for renewal of the scholarship, but they must reapply with all other applicants.
<b>Earl Moulder Hotel Administration Endowed Scholarship Fund</b>	Awarded annually to a junior majoring in Hotel Administration with an overall GPA of 3.0. Scholarship automatically renewed for one additional year as long as the student maintains satisfactory academic progress.
<b>Ed Huffman Mathematics Scholarship</b>	Awarded annually to a full-time undergraduate sophomore or greater, majoring in Mathematics (including Pre-Engineering) or Mathematics Education that has a departmental GPA of 2.5 and has completed the first Calculus course required by the major. Priority given to students that do not receive other scholarships covering tuition. Scholarship recipients may be considered for renewal of the scholarship but must reapply with all other applicants.

<b>Emil Lorz Memorial Scholarship</b>	Awarded annually to juniors or seniors majoring within the Chemistry Department with at least 20 hours in Chemistry and a departmental GPA of 3.8 and an overall GPA of 3.5. Must be enrolled full-time. Recipients may be considered for renewals but must reapply with all other applicants.
<b>Engineering Program Scholarships</b>	There are currently no requirements for this scholarship other than being a student seeking a degree in Engineering through the Cooperative Engineering Program. This scholarship is not renewable.
<b>Esther H. Scarlett Memorial Ecology Scholarship</b>	Awarded annually to a full-time graduate student in the College of Natural and Applied Science with a program of study emphasizing ecological concerns. Must have an undergraduate GPA of 3.0 and GPA of 3.5 in field of graduate study. Awards made with regard for financial need. Preference given to students that are married with children. Scholarship recipients may be considered for renewal but must reapply with all other applicants.
<b>Eugene H. Henderson Memorial Scholarship</b>	The Recipient of this award will be made to a junior, senior or graduate student with a declared major in Physics, Astronomy and Materials Science. First preference shall be given to a First-Generation student with financial need. Second preference shall go to a first-generation student. Third preference shall go to a student demonstrating financial need. This scholarship will be renewed automatically as long as the student continues to meet all criteria.
<b>Eugene T. Scafe Memorial Scholarship</b>	Awarded annually to a student majoring within the Chemistry Department with an overall and departmental GPA of 3.0. Must have 18 hours in Chemistry completed and an overall minimum of 60 hours completed. The scholarship will be automatically renewed for a maximum of two years as long as the student maintains a cumulative 3.0 GPA.
<b>Evelyn Maxwell Endowed Scholarship Fund</b>	Awarded annually to a full-time freshman or transfer student majoring in Mathematics Education. Incoming freshman should be in the top 33% of their class and submit a letter of recommendation from a high school mathematics teacher. Transfer students should have an overall GPA of 2.5. Preference given to students with financial need. This scholarship is not renewable.
<b>Evelyn Ruark Leonard STEM Scholarship</b>	The recipient of this award will be a sophomore, junior, or senior enrolled in one of the following science-based majors: Math, Engineering, Physics, Chemistry, or Biology. The student must be active within a student professional organization related to STEM. The student must have started an internship or undergraduate research (unless an Engineering major). The student must have a minimum GPA of 3.0 or higher. The student will hold the scholarship for one academic year. It may be renewed through graduate school, should the student reapply for consideration with all other applicants.

<p><b>Fagerlin-Johnson-Moeglin Field Studies Scholarship</b></p>	<p>At least two scholarships awarded annually - One to Geography or Planning major enrolled in GRY 470 or its equivalent during the Summer session and One to Geology or Earth Science Education major enrolled in GLG 412 or 413 or its equivalent during the Summer session. Preference given based on academic performance with previous three semesters being more heavily weighted. Students must have a cumulative and departmental GPA of 3.0. This scholarship is renewable, but the student must reapply. Student must be enrolled in at least one hour over the summer to receive aid. This scholarship is awarded in full in the summer.</p>
<p><b>Foundation for Immunotoxicology Award</b></p>	<p>Two awards are presented annually two full-time students - one to Biology major and one to a Chemistry major. Both must have completed 12 hours in their major and have an overall GPA of 3.5. Applicants must be nominated by faculty within the Department of Biology and the Department of Chemistry. Student must provide a personal statement discussing merits and future goals. This scholarship is renewable, but the student must reapply.</p>
<p><b>Fred and Diane May Planning Scholarship</b></p>	<p>The recipient of this award will be an undergraduate degree-seeking student majoring in Community and Regional Planning and properly enrolled at Missouri State University. Recipients must have at time of application, and maintain, at least a 3.0 cumulative GPA. Preference will be given to students who are members of the Missouri Association of Planning Students or the American Planning Association, and who have demonstrated financial need. The scholarship may be renewed, but the student must reapply annually.</p>
<p><b>Gerald Perry Memorial Scholarship</b></p>	<p>Awarded annually to a full-time undergraduate Biology major. Incoming freshman considered based on high school academic performance and leadership; all current students must have an overall GPA of 3.0. Scholarship will be automatically renewed as long as the student maintains satisfactory academic progress.</p>
<p><b>Hanover Scholarships for Mathematics</b></p>	<p>Awarded annually to a graduate or undergraduate student seeking a degree in Mathematics or Mathematics Education. The recipient may be considered for renewal, but they must reapply with all other applicants.</p>
<p><b>Harriett H. Ford Memorial Scholarship in Chemistry</b></p>	<p>Awarded annually to a full-time incoming freshman who has completed an AP or IB Chemistry course or has won a science fair competition with a Chemistry related project. Must have overall high school GPA of 3.2. Must submit letter from high school chemistry teacher attesting to students' interest and commitment to Chemistry and confirming they meet the requirements. Serious consideration will be given to all ways in which potential recipients might contribute to a diverse educational environment. This scholarship is not renewable.</p>

<p><b>Harthcock Chemistry Research Fellowship</b></p>	<p>The Recipients(s) of this award will be a graduate student(s) properly enrolled at Missouri State University with an overall undergraduate GPA minimum of 3.2 and a GPA minimum of 3.5 in Chemistry course work. Recipient(s) must conduct applied research in pursuit of their Masters of Science in Chemistry. Applied research is defined (and determined by the Chemistry Department Head) as that research that would be of interest by a for-profit company engaged in similar research that the student is conducting or that a company would have interest in such research to the point they could consider funding such research. Recipient(s) must have received their undergraduate degree in Chemistry from a college or University within the United States. The student(s) will hold the Fellowship for one academic year. The Fellowship can be renewed for one additional year (two years maximum) if the Chemistry Department Head views this is the best use of the Fellowship versus awarding this to a first year student. If this is a renewal for a second year, to be eligible the student must be in good standing with the university and their GPA for their graduate work at MSU the first year must be a minimum of 3.5. The Fellowship can be given to one or several graduate students pursuing a Master of Science degree in Chemistry at Missouri State University based on available funds. This fellowship will be selected and tracked through Scholarship Manager and selections will be verified by the Foundation/Financial Aid, but the students will be awarded the money through a stipend instead of on their student account.</p>
<p><b>Hein Family Scholarship in Hospitality Leadership</b></p>	<p>The scholarship shall be awarded to up to three students per year. The first award shall be made with preference given to an incoming freshman with satisfactory academic performance in high school. If there are no qualifying applicants, the scholarship shall be awarded to a student currently enrolled in Hospitality Leadership with a 2.5 GPA or higher. The second award shall be given to one or two students with preference given to a student enrolled in Hospitality Leadership employed by Chartwells Higher Education. If there are no qualifying applicants, the scholarship shall be awarded to a student(s) enrolled in Hospitality Leadership with a 2.5 GPA or higher. The students will hold the scholarships for one academic year. Scholarship may be renewed but will need to reapply each year.</p>
<p><b>Hospitality Leadership Board of Advisors Scholarship</b></p>	<p>Awarded annually to an undergraduate student seeking a degree in the Hospitality Leadership Department. Student must have completed 30 hours. Preference should be given to those students that have at least 1 year experience working in the hospitality industry. This scholarship may be renewed, but the student must reapply.</p>
<p><b>Hospitality Leadership-Scholarships</b></p>	<p>There are currently no requirements for this scholarship other than being a student seeking a degree in Hospitality Leadership. This scholarship is renewable, but the student must reapply.</p>

<p><b>Hotel Nikko San Francisco Hospitality Leaders Scholarship</b></p>	<p>Awarded annually to full-time juniors or seniors seeking degrees in the Hospitality and Restaurant Administration Department. Rather than applying, candidates for consideration will be nominated by the HRA Faculty. Those nominations will be based on students most likely to succeed if they were to seek careers at the Hotel Nikko - San Francisco. Preference should be given to students graduating in December each year and ready to work at Hotel Nikko the following January/February. Second preference would be for students graduating in May, but able to finish up their course work via online courses in order to start at Hotel Nikko immediately in May or June (Still allowing for students to start in January/February while continuing studies remotely.) Third would be students graduating in May and having the ability to start the first week of June. Students selected to receive this scholarship are not required but will be incited and receive first preference to participate in a Manager-In-Training (MIT) Program with the Hotel Nikko - San Francisco following graduation. Students will interview with members of the Hotel Nikko - San Francisco Management Team to ensure a successful placement. Through successful completion of the Hotel Nikko - San Francisco MIT, students will be offered an interview opportunity for management positions at Hotel Nikko properties, including the San Francisco location, and could be offered an additional signing bonus by the Hotel Nikko if a management of MIT position is available and offered. The award may be renewed, but the student must reapply or be re-nominated for full consideration. This scholarship will be paid in full in the fall.</p>
<p><b>Howard Petefish Award</b></p>	<p>Awarded annually full-time student majoring in Physics. Award given at end of students junior year. Must have overall GPA of 3.0 and a departmental GPA of 3.5. This scholarship is not renewable.</p>
<p><b>Hurtado Family Scholarship</b></p>	<p>Awarded annually to a student seeking a major in the College of Natural and Applied Sciences with an overall GPA of 2.0. First preference will go to students involved in ROTC and applicants who would not qualify for other scholarships based on GPA or standardized tests alone. Consideration will be given to academic performance, future potential, and leadership skills. Scholarship is for one year, but the student may be considered for renewal if they reapply for consideration with all other applicants.</p>
<p><b>James K. Bass Scholarship for Geology Field Studies</b></p>	<p>At least two scholarships will be awarded annually with a value of at least \$2,000 each. Awards will be given to undergraduate students majoring in Geology that will be enrolled in a required Field Studies Course. Students must submit a Personal Statement explaining their motivation and interest in the field of Geology. Preference will be given to need. Students must be enrolled in at least one summer credit to receive this award. This scholarship is not renewable and will be paid in full in the summer.</p>

<b>Jim Downing Mathematics Scholarship</b>	Student must be a full-time MSU mathematics or mathematics education major with a minimum 2.5 GPA in mathematics. Recipients may be considered for renewal but must reapply for consideration with all other applicants.
<b>Joe Crosswhite Mathematics Education Middle School Scholarship</b>	Awarded annually to a full-time junior or greater majoring in Middle School Education with a Mathematics emphasis with an overall and Missouri State GPA of 2.75 and a GPA of 3.0 in area of study. Must have been admitted without condition to the Missouri State Teacher Education Program, have completed Foundations of Mathematics, and one of the following: Foundations of Geometry for Teacher or Foundations of Probability and Statistics for Teachers. Preference given for financial need. Scholarship recipients can be considered for renewal of the scholarship but must reapply.
<b>John N. and Kathleen Griesemer Scholarship</b>	Awarded annually to an incoming freshman or transfer student enrolled full-time seeking a degree in the Geography, Geology, and Planning Department. Freshmen will be considered based on their academic credentials, leadership, and aptitude tests, while transfer students must have a transfer GPA of 3.0. This scholarship is not renewable.
<b>John W. Northrip Memorial Scholarship</b>	Awarded to a full-time junior or senior majoring in Physics with an overall and departmental GPA of 3.0. This scholarship is not renewable.
<b>Justice Jeweler's Food and Wine Fund</b>	Student must be a full-time student majoring in Hospitality and Restaurant Administration. Consideration will be given to students who demonstrate potential for college success. When awarded to a student enrolled at the sophomore level or higher, the student must have achieved an overall GPA of 2.5. Preference is given to a student that demonstrates financial need. This scholarship may be renewed, but the student must reapply.
<b>Karen and Bruno Schmidt Scholarship Fund</b>	Awarded annually to a full-time student majoring in a program within the College of Natural and Applied Sciences demonstrating leadership qualities and financial need. For incoming freshman, consideration will be given to high school performance and college potential. For continuing students, academic performance will be considered. Students may be considered for renewal if they reapply and maintain a 3.0 cumulative GPA.
<b>Kenneth A. Soxman Memorial Scholarship</b>	Awarded annually to a full-time student majoring in Physics with a departmental GPA of 3.0. The student must have a serious desire to teach high school physics, as determined by a committee of the physics faculty. This scholarship is not renewable.

<p><b>Kenneth C. Thomson Memorial Scholarship</b></p>	<p>Awarded annually to a full-time Geology major. Consideration of academic performance in the Geology field with greater weight for course taken in the previous three semesters. Preference for those expressing interest in caves and karst terrain through completion of GLG 350 or its equivalent or GLG 499 or its equivalent. Preference also given to those not receiving scholarships from the same department. This scholarship is renewable, but the student must reapply.</p>
<p><b>Kim Knight Memorial Scholarship</b></p>	<p>Awarded annually to full-time student majoring in Hospitality Leadership. Sophomores or greater must have an overall and departmental GPA of 3.0. Awards made with regard for financial need. Scholarship automatically renewed as long as the student maintains a cumulative GPA of 3.0.</p>
<p><b>Lawrence E. and Crystal Pummill Scholarship</b></p>	<p>Three scholarships will be awarded annually to full-time students, with one award going to the entering freshmen that received 1st Place in either individual or team competitions in the Lawrence E. Pummill Math Relays and two awards being given to a sophomore or greater majoring in Mathematics. Preference will be given to those preparing to teach mathematics. Freshmen award will also be based on high school academic performance and leadership qualities. Sophomores or greater must have an overall GPA of 3.0 and a departmental GPA of 3.5. All awards made with regard to financial need. The freshman award is not renewable. The other previous scholarship recipients may be considered for renewal of the scholarship but must reapply with all other applicants.</p>
<p><b>Lisa Reece Memorial ASceD OTC Transfer Scholarship</b></p>	<p>The Recipient of this award will be an undergraduate Ozarks Technical College transfer student properly enrolled at Missouri State University. Preference should be given to students that completed an Associate of Science in Engineering, Chemistry, Biology, Math or Computer Science at Ozarks Technical College. The recipient should be enrolled in one of the following science-based majors within the College of Natural and Applied Sciences: Math, Engineering, Physics, Chemistry, Computer Science or Biology. Involvement in activities will be considered, but not required. Recipient should have a minimum GPA of 2.75. A letter of recommendation from an OTC Associate of Science faculty or advisor will be taken into consideration. The student will hold the scholarship for one academic year and may not be renewed.</p>
<p><b>Louis O. and Minnie M. Smith Endowed Scholarship</b></p>	<p>Awarded annually to full-time student in the department of Mathematics with an expressed interest in a career in teaching Mathematics. Awards will be made with regard for financial need. Scholarship will be automatically renewed as long as the student maintains a cumulative GPA of 3.0.</p>

<b>Louise and Roland Harthcock Scholarship</b>	Awarded annually to a full-time undergraduate student in the Department of Chemistry on the Women's Intercollegiate Softball Team, with a recipient from Chemistry and a recipient from Softball. Incoming freshmen must be in the top 25% of their class and demonstrate leadership. Sophomores or greater must have an overall GPA of 3.0. and Chemistry majors must have a departmental GPA of 3.25. This is a one-time award and may not be renewed.
<b>Martin-Stevenson Science Scholarship</b>	Awarded to a senior science major (not Mathematics) awarded at end of junior year based on outstanding scholastic achievement and financial need. Ineligible if receiving Board of Governors or Presidential Scholarship.
<b>Mathematics Department Scholarships</b>	Awarded annually to a full-time Mathematics and Mathematics Education major. Sophomores or greater must have a departmental GPA of 3.0. Recipients may be considered for renewal but must reapply with all other applicants.
<b>Mathematics Emeritus Faculty Scholarship</b>	The Recipient of this award will be a(n) (undergraduate or graduate) student properly enrolled at Missouri State University within the College of Natural and Applied Sciences with a major in mathematics or mathematics education. The recipient will be a full-time student with a GPA of 3.0 in mathematics when awarded to a student of sophomore level or higher. When award to an incoming freshman, consideration will be given to high school academic performance and leadership. Recipients may be considered for renewal but must reapply with all other applicants.
<b>Mel Foster Computer Science Scholarship</b>	Awarded annually to a full-time student majoring in Computer Science who has completed less than 46 hours. Special consideration for freshmen that have completed at least CSC 131 (or its equivalent) and at most CSC 232 (or its equivalent); This scholarship is not renewable.
<b>Meredith Family CNAS Scholarship</b>	The recipient of this scholarship will be an undergraduate student properly enrolled full time at Missouri State University receiving a degree in the College of Natural and Applied Sciences with a GPA of 3.0 or higher. It is also the donor's preference: The student be a first-generation higher education student; The student be a Resident Assistant at Missouri State University; Be a Tennessee or Nebraska native. The scholarship may be renewed, but the student must reapply for consideration.
<b>Milton D. Rafferty Scholarship Fund</b>	Awarded annually to a full-time sophomore or greater majoring in Geography or Planning with an overall GPA of 3.0 and a departmental GPA of 3.25. This scholarship may be renewed, but students must reapply each year.
<b>Milton Topping Memorial Fund</b>	Student must be enrolled in the Biology graduate program and submit a typed proposal describing the research to be conducted if the summer assistantship is granted.



	<p>Preference will be given to beginning graduate students. This scholarship is not renewable.</p>
<p><b>Monsanto Company Science and Mathematics Scholarship</b></p>	<p>Awarded to a full-time student in the College of Natural and Applied Sciences who has completed between 90 and 110 credit hours, with a departmental GPA of 3.75. Awards will be made with regard to financial need. Students may be considered for renewal but must reapply with all other applicants.</p>
<p><b>Morton-Wilson Memorial Scholarship</b></p>	<p>The Recipient of this award will be an incoming freshman properly enrolled full-time at Missouri State University pursuing a degree in the Hospitality Leadership Department. Consideration will be given to high school performance, college aptitude tests and to leadership qualities. Preference will be given to students with demonstrated financial need. The student will hold the scholarship for one academic year. The scholarship may be renewed automatically for one additional year so long as students maintain satisfactory academic progress and continue to have financial need. Juniors and seniors are not eligible for this award.</p>
<p><b>O'Reilly Hospitality Management Scholarship</b></p>	<p>The Recipient of this award will be a Junior student properly enrolled at Missouri State University within the Department of Hospitality Leadership. The recipient must be seeking a degree in General Operations, Lodging, Food and Beverage, Tourism, or Club Management; The recipient must demonstrate financial need; The recipient must complete an essay illustrating experience or interest in community service and/or sustainability. Preference will be given to applicants currently employed by O'Reilly Hospitality Management. This scholarship is not renewable.</p>
<p><b>Ozark Chapter Missouri Society of Professional Engineers Leo Day Scholarship</b></p>	<p>\$1,500 scholarships will be awarded annually to an incoming freshman properly enrolled full-time that is a US citizen majoring in Civil Engineering, Electrical Engineering, Pre-Engineering, or any other future degree option available through the Engineering Program. The student must have a high school GPA of at least 3.0 and must submit a personal statement discussing their career goals and merit. Preference will be given to students submitting at least two letters of recommendation from high school instructors, advisors, or administrators. Preference should also be given to applicants with a parent or grandparent that is a current or life member of the Ozark Chapter Missouri Society of Professional Engineers. High school GPA, ACT score, curricular and extracurricular involvement, and high school class rank will also be considered. The student will hold the scholarship for one academic year. The scholarship is automatically renewable for a second year as long as the student maintains enrollment in the Engineering Program.</p>
<p><b>Pasta Express Hospitality and Restaurant Administration Scholarship</b></p>	<p>Awarded annually to a full-time sophomore or greater majoring in Hospitality Leadership with a departmental GPA</p>

	of 3.0. This scholarship is renewable, but the student must reapply.
<b>Paul L. &amp; Alice W. Redfearn Undergraduate Research Award</b>	Awarded annually to an undergraduate student majoring in Anthropology, Biology, Geography, or another area of Natural History. Student can be enrolled in graduate courses. Student must conceive an original research project on the natural history of the Ozarks. The award will be made for the semester/school year in which the research will be conducted. This is a one-time award.
<b>Pete Sanderson Scholarship</b>	Awarded annually to a full-time Computer Science major that has completed less than 46 hours. Special consideration for freshmen that have completed at least CSC 131 (or its equivalent) and at most CSC 232 (or its equivalent). This scholarship is not renewable.
<b>Physics and Astronomy Department and Friends Scholarship</b>	There are currently no requirements for this scholarship other than being a student seeking a degree in either Physics, Engineering Physics, Physics Education, or a minor in Astronomy. This scholarship is not renewable.
<b>Pre-engineering/Engineering Physics Scholarship</b>	Awarded annually to a full-time undergraduate majoring in the Physics, Astronomy, and Materials Science Department. Incoming freshmen considered based on high school academic performance and leadership. Sophomores or greater must have an overall GPA of 2.75 and a departmental GPA of 3.0. Preference given to student demonstrating hands-on engineering aptitude. This scholarship is renewable, but the student must reapply.
<b>Rich and Cindy Miller Computer Science Endowed Scholarship</b>	Scholarship will be awarded annually to one undergraduate or graduate student properly enrolled full-time at Missouri State University seeking a degree within the Department of Computer Science. Eligible candidates must be in good academic standing. Demonstrated financial need is preferred as are recipients who are first generation college students. Student must also successfully complete at least one Computer Science course toward their degree each semester. The recipient will hold the scholarship for one academic year. The scholarship may be renewed, but student must reapply.
<b>Robert Lloyd Ernst Chemistry Graduate Summer Assistantship</b>	Awarded as the equivalent of a regular summer teaching assistant stipend to a graduate student in the Chemistry Department. Preference given to student that can complete Masters degree with this additional summer funding. Preference given to a student whose graduate advisor lacks funding for summer assistantship. If all qualifications are equal, preference will be given to student demonstrating financial need. The student will receive this award in the summer semester, so they must be enrolled in at least one hour over the summer. This is a one time award and is not renewable.

<p><b>Robert S. Christie Memorial Scholarship</b></p>	<p>Awarded annually to a full-time student majoring or minoring in the Chemistry Department that has worked in the chemical stockroom or in the research laboratory. If all qualifications are equal, preference is to be given to a student demonstrating financial need. Recipients may be considered for renewal but must reapply with all other applicants.</p>
<p><b>Robin Melton Science Scholarship</b></p>	<p>Awarded annually to a full-time undergraduate majoring in a program in the College of Natural and Applied Sciences. Must have an overall GPA of 3.0 and a GPA of 3.5 in their field of study. Serious consideration will be given to all ways in which potential recipients might contribute to a diverse educational environment. Preference is given to sophomores. Scholarship recipients may be considered for renewal of the scholarship but must reapply with all other applicants.</p>
<p><b>Russell G. Barnekow, Jr. Memorial Scholarship</b></p>	<p>Awarded annually to an outstanding graduate student in Biology. Must have an overall undergraduate and departmental GPA of 3.6. Awards made with regard to financial need. This scholarship may be renewed, but the student must reapply.</p>
<p><b>Sarah Elsea Scholarship</b></p>	<p>The Recipient of this award will be a sophomore or junior student properly enrolled at Missouri State University as a full-time student. Biology, Chemistry, Physics Astronomy and Material Science, Computer Science, Engineering, Geography, Geology and Planning or Mathematics majors who are participating in a summer internship are eligible. Recipient must have a minimum GPA of 3.0. This scholarship will be awarded in full in the summer. The scholarship may be renewed but students must reapply and be considered with all other applicants.</p>
<p><b>Shirley Huffman Scholarship</b></p>	<p>The recipient of this award will be an undergraduate student, properly enrolled as a full-time student at Missouri State University, that has completed 80+ credit hours, has a GPA of 3.0 or higher and is pursuing a degree in Mathematics. It is the preference of the donor that the recipient be a first-generation higher education student; the student have financial need, this scholarship may be renewed, but must reapply for consideration with all other applicants.</p>
<p><b>Steve and Nancy Jensen Biology Scholarship</b></p>	<p>Awarded annually to a full-time junior or senior Biology major with preference going to those students with an interest in invertebrate biology. Must have an overall GPA of 3.25.</p>
<p><b>The Kunkel Scholarship Fund</b></p>	<p>Awarded annually to a full-time graduate or undergraduate student seeking a degree in the sciences. First preference will go to students with financial need, particularly those with EFCs and grant aid less than total cost of attendance. Student must have a cumulative GPA of 3.0. Student should demonstrate academic excellence, character, and leadership.</p>

<p><b>The Tom Smith Scholarship</b></p>	<p>The recipient of this award will be an undergraduate student properly enrolled at Missouri State University as a Hospitality Leadership major with a minimum of 60 credit hours. Preferences should be given to a student who is employed at Highland Springs Country Club and/or have at least one year of experience working in the hospitality industry. The student will hold the scholarship for one academic year. The scholarship may be renewed, but the student must reapply</p>
<p><b>Thomas Cave Endowed Astronomy Scholarship</b></p>	<p>The recipient(s) of this scholarship will be an undergraduate student(s) properly enrolled at Missouri State University, with a declared major in Physics with the Astronomy and Astrophysics option. Recipients of the scholarship will be enrolled at the sophomore level or higher and must have completed an introductory course in astronomy (AST 113, 114, or 115) prior to selections of the scholarship award. Recipients should also have maintained a minimum GPA of 3.0 in Physics, Astronomy, or Material Science courses. Scholarship awards will be made with first preference for those students with demonstrated financial need. Scholarship recipient may be considered for renewal, but must reapply each year.</p>
<p><b>Thomas Shiflett Scholarship</b></p>	<p>Student must be a full-time mathematics major for the purpose of teaching mathematics. Student must also have a minimum 3.0 GPA in mathematics.</p>
<p><b>Thurman Family Scholarship</b></p>	<p>The recipient of this award will be an undergraduate full-time student properly enrolled at Missouri State University. Recipient will be majoring in Physics and must have completed at least three credit hours of Physics courses at Missouri State University above the level of the first introductory calculus-based Physics course. Recipient must have an overall GPA greater than or equal to 3.0 and a GPA in the major greater than or equal to 3.0. Financial need is preferred, but not required. The scholarship may be renewed, but the student must reapply each year for consideration.</p>
<p><b>Tom Stombaugh Scholarship</b></p>	<p>Awarded annually to a full-time junior or greater majoring in Biology with an overall and departmental GPA of 3.0 and 15 hours of Biology courses including BIO 235 or its equivalent. Preference given to student planning a career in medicine.</p>
<p><b>Vincent E. Kurtz Scholarship</b></p>	<p>Awarded annually to full-time sophomore or junior majoring in Geology with at least 12 hours complete in degree program. Must have an overall and departmental GPA of 3.0. Preference given to students not receiving any other departmental scholarships.</p>
<p><b>Wallace R. Weber Biology Scholarship</b></p>	<p>Awarded annually to one student that is full-time and majoring in either Biology or Botany. First preference will go to a graduate Botany student, second preference will go to an undergraduate Botany student, and third preference will go to an undergraduate Biology major.</p>

<p><b>Wallace R. Weber Memorial Scholarship</b></p>	<p>Awarded annually to a student majoring in Botany or Biology. First preference to graduate student in Botany program. Second preference to undergraduate majoring in Botany. Third preference given to undergraduate majoring in Biology.</p>
<p><b>Warren C. and Vivian M. Rauch Memorial Award</b></p>	<p>One \$1,200.00 cash award (or whatever amount is available if it is below \$1,200.00) will be provided to an undergraduate student seeking a degree in Geology that is enrolled to take a summer field studies geology course (GLG 412 or 413). The selected recipient will receive a single cash award that will help offset the costs of tuition and course fees for a field studies geology course through another university that allows the credits to transfer automatically to Missouri State University.</p>
<p><b>WEB and AOB Scholarship Award</b></p>	<p>Awarded annually to a full-time student seeking a MS in Chemistry with an overall GPA of 3.0. Student must submit a one page summary of their thesis project, and preference should go to those students with a project related to organic, medicinal, or environmental chemistry.</p>
<p><b>Wildlife Scholarship</b></p>	<p>Awarded annually to a full-time student seeking a degree in Agriculture or Biology. Graduate students must have undergraduate GPA of 3.0 and a GPA of 3.5 in their degree program. Undergraduates must have an overall GPA of 3.0.</p>
<p><b>William J. Husa Chemistry Scholarship</b></p>	<p>Awarded annually to a full-time junior or senior majoring in Chemistry with an overall GPA of 3.0. Preference should be given to those with a demonstrated interest in a Chemistry Research that have taken or are enrolled in CHM 399 or 499.</p>
<p><b>Wyman and Sue Grindstaff Chemical Education Scholarship</b></p>	<p>Awarded annually to full-time undergraduate majoring in Chemistry with a minimum of 14 hours Chemistry courses complete. Sophomores or higher must have a departmental GPA of 2.75. Preference given to students demonstrating interest in Chemical Education. All else equal, preference given to students demonstrating financial need.</p>

# ***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 Sciences (MS)**
- **Geospatial Sciences in Geography and Geology (MS)**
- **Materials Science (MS)**
- **Mathematics (MS)**
- **Mathematics Education (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](mailto:GraduateCollege@MissouriState.edu) (417-836-5335) to determine admission requirements and procedures, <https://graduate.missouristate.edu/futurestudents/Accelerated.htm>