MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

# 17th Annual Undergraduate Research Conference


Larry Gragg is Distinguished Teaching Professor Emeritus and University Historian at Missouri S&T. He began teaching at the University of Missouri-Rolla in 1977 and served as chair of the history and political science department for 17 years, one year as vice-provost for undergraduate studies, and was the founding chair of the Center for Advancing Faculty Excellence. He won more than 20 teaching awards including the Missouri Governor's Award for Excellence in Teaching and the University of Missouri President's Award for Outstanding Teaching. He also received the University of Missouri Board of Curators' Award for Scholarly Excellence and the University of Missouri Thomas Jefferson Award. He is the author of ten books including *Forged in Gold: Missouri S&T's First 150 Years* (2020).

A celebration of experiential learning at Missouri S&T

**April 14, 2022**

*Havener Center*

# 17th Annual
## Undergraduate Research Conference
## April 14, 2022

## Table of Contents

# 17th Annual Undergraduate Research Conference

| | |
|---|---|
| 8:30am – 9:00am | **Registration**<br>*(Upper Atrium)* |
| 9:00am – 12:00pm | **OURE Fellows Oral Sessions**<br>**Fellows Final Reports**<br>*(Ozark Room)* |
| 10:00am – 12:00pm | **OURE Fellows Oral Sessions**<br>**Fellow Proposals**<br>*(Missouri Room)* |
| 12:00pm – 1:00pm | **Welcome – Dr. Kathy Northcut**<br>**Vice Provost of Academic Support**<br><br>**Luncheon & Keynote Address**<br>***Dr. Larry Gragg***<br>Distinguished Teaching Professor Emeritus<br>and<br>University Historian at Missouri S&T<br>***Presents***<br>"Researching the History of MSM/UMR/S&T"<br>*(St. Pat's B Ballroom)* |
| 1:00pm – 1:30pm | **Registration and Poster Set-Up**<br>*(Upper Atrium)* |
| 1:30pm – 3:00pm | **Oral Sessions**<br>**Arts & Humanities --- Engineering**<br>*(Gasconade Room)* |
| 1:30pm – 3:00pm | **Oral Sessions**<br>**Sciences – Sections 1-2-3**<br>*(Section 1, Meramec Room) (Section 2, Missouri Room) (Section 3, Ozark Room)* |
| 1:30pm – 3:00pm | **Poster Sessions**<br>**Arts & Humanities --- Engineering --- Research Proposals --- Sciences**<br>*(Upper Atrium)* |
| 3:00pm – 4:00pm | **Reception**<br>*(St. Pat's B Ballroom)* |
| 4:00pm – 5:00pm | **Awards Ceremony**<br>*(St. Pat's B Ballroom)* |

**Judges Conference Room – (Mark Twain)*

# *Conference Judges*

The Office of Academic Support wishes to thank the faculty, staff, and students for their valuable contributions to the 17th Annual Missouri S&T Undergraduate Research Conference.

Dr. Diana Ahmad of History & Political Science
Dr. Andrew Behrendt of History & Political Science
Dr. Devin Burns of Psychological Science
Dr. Aleksandr Chernatynskiy of Physics
Dr. Petra Dewitt of History & Political Science
Dr. David Duvernell of Biological Sciences
Dr. Rainer Glaser of Chemistry
Dr. Karen Head of English & Technical Communication
Dr. Irina Ivliyeva of Arts, Languages, and Philosophy
Ms. Kendrea James of English & Technical Communication
Dr. DongHyun (Bill) Kim of Electrical & Computer Engineering
Ms. Rachel Kohman of Kummer Institute
Dr. Jossalyn Larson of English & Technical Communication
Dr. Kelly Liu of Geosciences & Geological & Petroleum Engineering
Ms. Rachel Morris of Institutional Research & Data Management
Ms. Elizabeth Roberson of English & Technical Communication
Dr. Michelle Schwartze of Teacher Education & Certification
Dr. Ting Shen of Psychological Science
Dr. Risheng Wang of Chemistry
Dr. Guang Xu of Mining Engineering

# Oral Presentations

## Tuesday – April 14, 2022

### Arts and Humanities

| Name | Department | Time | Location |
|---|---|---|---|
| James Drennan | Arts, Languages, & Philosophy | 1:30-2:00pm | Gasconade |
| Donovan Mefford | History & Political Science | 2:00-2:30pm | Gasconade |

### Engineering

| Name | Department | Time | Location |
|---|---|---|---|
| Jacob Head | Geosciences & Geological & Petroleum Engineering | 2:30-3:00pm | Gasconade |

### Sciences – section 1

| Name | Department | Time | Location |
|---|---|---|---|
| Reece Beattie-Hauser | Physics | 1:30-2:00pm | Meramec |
| Joey Gloriod | Chemistry | 2:00-2:30pm | Meramec |
| Anthony Lonsdale | Physics | 2:30-3:00pm | Meramec |

### Sciences – section 2

| Name | Department | Time | Location |
|---|---|---|---|
| Samuel Hackett | Chemistry | 1:30-2:00pm | Missouri |
| Darrien McKenzie | Computer Science | 2:00-2:30pm | Missouri |

### Sciences – section 3

| Name | Department | Time | Location |
|---|---|---|---|
| Allison Hermelink | Chemistry | 1:30-2:00pm | Ozark |
| Michaela Quinones | Biological Sciences | 2:00-2:30pm | Ozark |
| Jordan Stevens | Physics | 2:30-3:00pm | Ozark |

# Reece Beattie-Hauser




Department: Physics
Major: Physics
Research Advisor: Dr. Thomas Vojta
Advisor Department: Physics



Funding Source: National Science Foundation


## Scalar Susceptibility of a Diluted Classical XY Model


The Higgs (amplitude) mode at the disordered superfluid-Mott glass quantum phase transition was recently shown to feature unusual localization properties that violate naive scaling [1,2,3]. To test whether analogous behavior also occurs in the classical case, we analyze the Higgs mode in a diluted 3D classical XY-model near the magnetic phase transition. We calculate the amplitude correlation function and the corresponding scalar susceptibility by means of Monte Carlo simulations. In contrast to the quantum case, we find that the scalar susceptibility fulfills naive scaling (employing the clean critical exponents, as expected from the Harris criterion) as the temperature is varied across the phase transition for several dilutions.



[1] M. Puschmann, J. Crewse, J. A. Hoyos, and T. Vojta, Phys. Rev. Lett. 125, 027002 (2020).
[2] J. Crewse and T. Vojta, Phys. Rev. B 104, 014511 (2021).
[3] M. Puschmann, J.C. Getelina, J.A. Hoyos, and T. Vojta, Ann. Phys. in press , arXiv:2101.11065


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*Reece is currently a junior majoring in physics, with the hopes of pursuing a PhD after graduation. He began doing research with Dr. Thomas Vojta during the Summer of 2020. Thankfully, the computational nature of their work allowed them to conduct research relatively unimpeded even during the height of the quarantine. He has a passion for both physics and computer science, so he's very happy to work in a field which combines the two.*

**James Drennan**



Department: Arts, Languages, and Philosophy
Major: Spanish
Research Advisor: M. Emilia Barbosa
Advisor Department: Arts, Languages, and Philosophy

Funding Source:

# La Fuerza de la Mujer (The Strength of Women)

Hailing from Spain and with a career that has spanned over thirty years, Pedro Almodovar has become one of the most successful modern filmmakers. His films have won him many prestigious accolades including the Academy Awards for Best Foreign Film and Best Screenplay. There are many components to his films that make him unique, specifically his use of the melodrama genre and colorful cinematography. However, his use of women in leading roles is looked at as his most important mark in cinema. The award winning films Volver and Hable con Ella are phenomenal examples of writer and director Pedro Almodovar's ability at writing well rounded and powerful women, which sprouted his success in the film industry.

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*James Drennan is a sophomore studying Civil Engineering as well as Spanish at the University of Missouri Science and Technology. With help and guidance from Spanish professor Emilia Barbosa, he researched and wrote a paper in Spanish on Pedro Almodovar. Almodovar is a filmmaker from Spain who is known for his complex melodramas and colorful cinematography. By writing the paper, James not only improved his Spanish, but also learned a lot about Spanish cinema.*

# Joey Gloriod





Department: Chemistry
Major: Chemistry
Research Advisor: Dr. Chariklia Sotiriou-Leventis
Advisor Department: Chemistry



Funding Source: NSF


## THQ Synthesis, Formation of Aerogels for CO2 Capture


The accelerated increase of carbon dioxide concentration in the atmosphere over the modern era damages natural ecosystems through ocean acidification and global warming. As such, carbon capture is an essential tool for regulating CO2 levels from rising further, or, ideally, decreasing the carbon footprint overall. This project's goal is to formulate new materials for high capacity and selective CO2 adsorption. The material of focus is polymerized from the newly synthesized tetrahydroquinazoline (THQ) monomer. THQ is prepared in a four-step synthesis and polymerized through an acid catalyzed ring-opening mechanism. The PTHQ wet gels are then dried in an autoclave using supercritical CO2, resulting in aerogels which are aromatized at 240C under O2. The fully oxidized PTHQ aerogels are then carbonized at high temperatures under inert gas to yield carbon aerogels. These aerogels are further etched at 1000C under CO2 flow to increase the micropore volume dramatically. Finally, the carbon aerogels are evaluated for CO2 adsorption capacity and selectivity. The etched carbon aerogels show very high CO2 adsorption at atmospheric pressure (1 bar) and 273K, as well as high selectivity towards CO2 in comparison to H2, CH4, and N2 gases. Overall, the PTHQ carbon aerogels show promise as future candidates for carbon capture.


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*Joey Gloriod is a senior in chemistry, and this is his second semester doing research in Dr Leventis's lab with PhD student Vaibhav Edlabadkar. He is on track to graduate in the fall of 2022 and plans to go into graduate school seeking a PhD in Organic Chemistry. Beyond chemistry, he has been an active participant in the MSM Spelunker's club and was president of Spectrum for the 2020-2021 academic year. He is passionate about chemistry and hopes to expand his knowledge in the field until he can eventually teach future generations to have the same passion for science.*

**Samuel Hackett**



Department: Chemistry
Major: Chemistry
Research Advisor: Chariklia Sotiriou-Leventis
Advisor Department: Chemistry

Funding Source: NSF

# Carbon Aerogels for High Capacity Adsorption of CO2

Carbon aerogels are light, highly porous materials with high surface areas. Their applications have been demonstrated in a wide range of areas such as CO2 capture, gas separations, electrochemical cells, catalysis, etc. Carbon aerogels are typically made from pyrolysis of a variety of carbonizable polymeric aerogels, which in turn are synthesized via sol-gel methods. It has been argued that along with porosity and the surface structure, heteroatoms such as O and N play a decisive role on the properties of porous carbon materials, with nitrogen-containing functional groups in particular responsible for improving interaction with gases for gas adsorption applications. For these reasons, a previously-synthesized tetrahydroquinazoline (THQ) monomer was selected to be polymerized to form a PTHQ aerogel, which was then oxidized, carbonized, and etched to form a carbon aerogel. This transformation process has variable steps, which affect the characteristics of the derived aerogel. This carbon aerogel exhibits porosity favorable for high capacity of carbon dioxide, and for the selective adsorption of carbon dioxide versus other common gases, notably nitrogen and oxygen.

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*Samuel Hackett is a freshman majoring in Chemistry from O'Fallon, Missouri. Through the FYRE program, Samuel has taken his first steps into research by examining carbon aerogels. He is also a member of the Chem-E-Car design team. Samuel has enjoyed studying chemistry ever since high school. While he is not doing coursework or research, he can usually be found reading or playing video games.*

# Jacob Head





Department: Geosciences and Geological and Petroleum Engineering
Major: Petroleum Engineering
Research Advisor: Dr. Baojun Bai
Advisor Department: Geosciences and Geological and Petroleum Engineering



Funding Source: OURE Funding


## Impact of Fiber on Re-crosslinkable Particle Gels


In the Petroleum industry, water is inadvertently produced during the production of hydrocarbons. Fluid flow in a heterogenic reservoir favors high permeable zones resulting in un-swept areas. As production continues, these areas become depleted of hydrocarbons and transition to a highway for waterflow. This results in a significant increase in the water-to-oil ratio, leading to the abandonment of the well, leaving approximately 2/3 of oil unrecovered. Re-crosslinkable preformed particle gel (RPPG) has been developed and implemented to restrict fluid flow in high permeable zones, redirecting fluid flow to un-swept areas of the reservoir. In this research, fiber was incorporated into the gel to increase its' plugging performance. Our lab results show that the addition of fiber increased the gel strength across the whole spectrum of conditions. For this reason, fiber can be used as an effective additive to enhance the RPPG plugging performance.


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*Jacob Head is a third-year student at Missouri University of Science and Technology, where he is pursuing a Bachelor of Science in Petroleum Engineering. Jacob is president of the Society of Petroleum Engineers Student Chapter. As president, he helps bring industry professionals and exposure to the student chapter here at Missouri University of Science and Technology. Jacob also strives to provide resources for student members to succeed in the oil and gas industry. As well as being president of SPE he is also an active member in International Association of Drilling Contractors and American Association of Drilling Engineers. In addition, he is also a four-time dean's list certificate recipient. His focus of interest is on enhanced oil recovery. In his free time Jacob enjoys foraging for mushrooms and fishing.*

# Allison Hermelink





Department: Chemical and Biochemical Engineering
Major: Biochemical Engineering
Research Advisor: Dr. Klaus Woelk
Advisor Department: Chemistry



Funding Source: OURE AY 21/22


## NMR Relaxometry of Syngas-to-Methanol Conversion

Methanol is an important raw material for many industrial and laboratory processes. It is synthesized by converting natural gas to a mixture of carbon monoxide and hydrogen gas. This mixture, called syngas, is then converted with help of a Cu-ZnO/Al2O3 catalyst to produce methanol. Only about 7% of methanol is yielded in a one-turn conversion. NMR relaxometry will be conducted in a specialized toroid-cavity probe to better understand the reactivity of the active sites of the catalyst. The toroid-cavity probe can record NMR relaxation times under industrial reaction conditions. A computational algorithm will be used to analyze multiexponential decay data and extract their correlated relaxation times. The relaxation times are associated with chemical environments for different reactive components of the methanol synthesis, such as freely moving molecules versus locally fixed molecules. The relaxometry results are used to identify yield-inhibiting processes such as water deposition on the catalytically active sites.

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*Allison Hermelink is a sophomore in biochemical engineering with a the goal of becoming a processing engineer in the cosmetic, drug, or food industry. She is a member of the Society of Women Engineers and a project leader for Engineers Without Borders and their Guatemala project. She is also an officer at the Chi Omega fraternity and a member of the Asian-American Association. In her free time, Allison teaches ballet to students (ages 6 - 21) at a local dance studio. For summer and fall of 2022, she has secured a Co-op with ICL Group in Laurence, Kansas, manufacturing phosphate compounds as additives for the food industry.*

# Anthony Lonsdale





Department: Physics
Major: Physics
Research Advisor: Dr. Aleksandr Chernatynskiy
Advisor Department: Physics



Funding Source: OURE


## Applying Spin Dynamics Methods to Uranium Dioxide


Experiments conducted on Uranium Dioxide (UO2) under the Manhattan Project led to the creation of the first self-sustaining nuclear reaction at Chicago Pile-1 in 1942. 80 years later, UO2 functions as the primary fuel for nuclear fission reactors, providing around 10% of global electric output. Understanding UO2's thermal and magnetic properties is instrumental in ensuring safe operation and handling, which can be done computationally using the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS). Recent advances in LAMMPS allow for the simulation of quantum spin-lattice coupling in magnetic subsystems, which we have applied to elemental Iron across magnetic phase transitions. Simulating spin-lattice coupling with LAMMPS requires the usage of magneto-mechanical potentials instead of classical potentials, which captures more of the relevant quantum-mechanical physics that are dominant in low-temperature magnetic subsystems. UO2 at low temperatures contains a non-trivial magnetic subsystem which is believed to be a result of quadrupole-quadrupole, magnetic exchange and phonon-magnon interactions, providing a challenge to simulate accurately. We discuss current progress made with using magneto-mechanical potentials to simulate the magnetic subsystem of elemental Iron and possible applications to UO2.


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*Anthony Lonsdale is a Senior undergraduate studying Physics at Missouri S&T. He is from Kansas City, Missouri and his interests include software development, financial markets and algorithmic finance. Anthony is an Eagle Scout, National level swimmer and entrepreneur. He started working with Dr. Chernatynskiy in the fall of 2019 under the FYRE program and presented his research for the Fuller Research Competition in the spring of 2020, and won second prize at the UGRC in Physics in the spring of 2021. He is currently working under the OURE program, and plans to continue until graduation. Anthony plans on pursuing an internship at the auto dealer technology firm ProMax for the summer and graduate in the fall semester.*

**Darrien McKenzie**



Department: Computer Science
Major: Computer Science
Research Advisor: Dr. Patrick Taylor
Advisor Department: Computer Science

Funding Source: OURE

# Reinforcement Learning in Spiking Neural Networks

Biological neurons communicate primarily via a spiking process. Recurrently connected spiking neural networks (RSNNs) more realistically model the brain, compared to their non-spiking counterparts. It is of great interest to discover a biologically realistic learning rule to achieve optimal levels of performance on machine learning tasks. Experimental data describe a phenomenon known as spike-timing-dependent-plasticity (STDP), which integrates local firing coincidences between neurons to learn. STDP is believed to underlie memory formation and storage within the brain. When a reward signal modulates STDP, it enables forming associative memories via operant conditioning. Neuromodulators like dopamine operate similarly in the brain. We employ processes like synaptic scaling to support R-STDP in large, unstructured RSNNs. Doing so produces an agent that achieves adequate performance on reinforcement learning tasks.

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*Darrien McKenzie is a junior Computer Science student at Missouri University of Science & Technology (MST) expecting to graduate with a bachelors in Spring 2023. Before he transferred to MST he gained industrial experience by working on Cerner's Data Intelligence team for almost two years. During Darrien's time at MST, he has engaged in undergraduate research for MST's Computational Neuroscience lab, headed by Dr. Taylor. His primary research interests involve reinforcement learning, neural networks, and automation. Darrien will begin working for Sandia National Laboratories in May 2022 under The Mathematics and Analytics Research Technical Internship for Advanced National Security (MARTIANS) program. After he acquires his bachelors, Darrien intends to pursue a PhD in Computer Science to further engage in artificial intelligence research.*

**Donovan Mefford**



Department: History & Political Science
Major: History
Research Advisor: Dr. Michael Bruening
Advisor Department:

Funding Source: History

# The Motivations & Goals in the German Peasants' War

The German Peasants' War, which lasted from 1524 to 1526, has been evaluated in many different ways by scholars. The war began as a result of the demands for reforms raised by peasants in Germany went unanswered. This uprising ultimately failed, but many scholars see it as an important precedent. Some Marxist and socialist historians see it as an early bourgeois revolution, while others have seen it as an early attempt to move towards a parliamentary democracy instead of monarchy. This research looks at the goals and motivations of the peasants in the German Peasants' War as evidenced through documents left from the time period. These documents reveal the nature of this rebellion and how it fits into the revolutionary history of Europe.

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*Donovan Mefford is a graduating senior in the Missouri S&T History and Political Science department pursuing a Bachelor of Arts in History with minors in Pre-Law, Philosophy, Political Science, and French. His main area of interest is in European history. Donovan plans to take a gap year to build experience before applying to law schools.*

**Michaela Quinones**



Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Dev Niyogi
Advisor Department: Biological Sciences

Funding Source: Dept of Biological Sciences and the OURE Program

# Nutrient Release from Aquatic Plants

Eutrophication is among the greatest threats to global freshwater. Methods such as floating treatment wetlands (FTWs) utilize aquatic plants to remove excess nutrients directly from the water column. However, plants senesce or die off seasonally, releasing nutrients back into the water. The harvesting of plant tissues can be employed to remove nutrients from the system more permanently. The effectiveness of these strategies is dependent on the amount of nutrients a senesced or dying plant releases. This study submerged four common Missouri macrophytes in conditions that prompted senescence and examined the nutrient concentrations over time. The amount of nutrients released varied among plant species, with emergent plants offering a more permanent sequestration than either submergent or floating plants, which over time release significant amounts of phosphorous and nitrogen compounds. The findings highlight the importance of plant tissue removal in reducing the nutrient concentrations in freshwater systems using FTWs.

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*Michaela Quinones is a junior studying Biological Sciences. Her main interests are in freshwater ecology, biodiversity, and conservation. She is an undergraduate with Dr. Dev Niyogi, and she participates in Water Environment Federation, Phi Sigma Biological Honor Society, and the S&T Equestrian Club. After graduating from S&T, she plans to continue her education with graduate studies.*

# Jordan Stevens

Department: Physics
Major: Physics
Research Advisor: Dr. Shun Saito
Advisor Department: Physics


Funding Source: The OURE Program

## “Early Dark Energy in Precision Cosmology”

The flat ΛCDM model of the Universe has started to falter due to recent and precise observations. A prominent example is the Hubble tension; the Hubble constant, the rate at which the universe is currently expanding, is different depending on the method used to measure it. One of the most promising models to resolve the tension is the axion-like Early Dark Energy (EDE) model. However, all the previous work on EDE models assumed a flat Universe. Since the detection of such a component has a significant impact on our understanding of fundamental physics, we must revisit the assumptions in the flat ΛCDM model. In this paper, we will systematically study the impact of the shape of the Universe on the EDE model in light of state-of-the-art cosmological observations. Our goal is to clarify how the EDE model and the shape of the Universe are simultaneously constrained with these recent datasets.

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*Jordan Stevens, from Terre du Lac Missouri, is a senior undergraduate in physics here at Missouri S&T. She plans on going to graduate school and getting her PhD in cosmology.*

# Poster Presentations

## Thursday – April 14, 2022

### Arts and Humanities

| Poster # | Name | Department | Time | Location |
|---|---|---|---|---|
| 1 | Gregory Dreisewerd | History & Political Science | 1:30 – 3:00pm | Upper Atrium |

### Engineering

| Poster # | Name | Department | Time | Location |
|---|---|---|---|---|
| 2 | Caleb Moellenhoff | Chemical & Biochemical Engineering | 1:30 – 3:00pm | Upper Atrium |
| 3 | Elizabeth Nolte | Electrical & Computer Engineering | 1:30 – 3:00pm | Upper Atrium |

### Research Proposal

| Poster # | Name | Department | Time | Location |
|---|---|---|---|---|
| 4 | Christian Bigler | Biological Sciences | 1:30 – 3:00pm | Upper Atrium |

### Sciences – section 1

| Poster # | Name | Department | Time | Location |
|---|---|---|---|---|
| 5 | Vaughn Foreman | Chemistry | 1:30 – 3:00pm | Upper Atrium |
| 6 | Jennifer Harrell | Biological Sciences | 1:30 – 3:00pm | Upper Atrium |
| 7 | Maya Washington | Biological Sciences | 1:30 – 3:00pm | Upper Atrium |

### Sciences – section 2

| Poster # | Name | Department | Time | Location |
|---|---|---|---|---|
| 8 | Alexis Baiter<br>Sage Wood | Biological Sciences | 1:30 – 3:00pm | Upper Atrium |
| 9 | Rachel Adcock<br>Stephan Houser<br>Mercedes Lane<br>Emma Puetz | Geosciences & Geological & Petroleum Engineering | 1:30 – 3:00pm | Upper Atrium |
| 10 | Amberly Scott<br>John Sneed<br>Kathryn Zychinski | Biological Sciences | 1:30 – 3:00pm | Upper Atrium |

**Rachel Adcock**

*Joint project with Stephan Houser, Mercedes Lane, and Emma Puetz*

Department: Geosciences and Geological and Petroleum Engineering
Major: Geology & Geophysics
Research Advisor: Dr. David Wronkiewicz
Advisor Department: Geosciences and Geological and Petroleum Engineering



Funding Source: Geology & Geophysics Department

# Mineral Compositional Changes During Weathering

The weathering of rocks is dependent on the mineral composition, climate, and tectonic environment. Goldich (1938) determined the relative weathering rate of minerals in igneous rocks was inversely proportional to their crystallization temperature (i.e. Bowen's Reaction Series). To test this relationship, we sampled weathered and unweathered granite, rhyolite and basalt rocks from the St. Francois Mountains, MO area. The samples were crushed, pulverized, and pressed into pellets suitable for X-ray diffraction (XRD) and X-ray fluorescence (XRF) analysis. XRD and microscopic analysis showed that the K-feldspar within the granite and rhyolite samples weathered to illite and kaolinite clays. From unweathered to weathered granite, our XRF data showed there was a residual enrichment of Al (from 15 to 27 wt.%), the Si content was conserved (from 70 to 65 wt.%), the K content decreased slightly (from 6.8 to 5.1 wt.%), and the presence of Na and Mn were below detection. XRD and microscopic analysis on the basalt sample showed an unusual enrichment of K, which weathered to illite and smectite, and the presence of weathered TiO2 product, anatase. Analytical results of XRF on the basalt and rhyolite will be discussed later in the report. The purpose of this research is to observe the changes of mineral compositions during modern weathering. This can reveal how weathering processes alter over time and during climate change.

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*Rachel Adcock is an undergraduate student at Missouri University of Science & Technology, majoring in Geology & Geophysics with a focus in paleontology. She is involved in the Honors Academy and is the vice president of the Tae Kwon Do Club. In her spare time, she enjoys reading, drawing, and hiking.*

**Lexi Baiter**

*Joint Project with Sage Wood*



Department: Biological Sciences
Major: Biological Sciences, Environmental Sciences
Research Advisor: Niranjana Krishnan
Advisor Department: Biological Sciences

Funding Source: FYRE, Missouri S&T Biological Sciences Department

# Enzyme Inhibitors and Insecticide Effect on Caterpillars

This project aims to determine why there is a significant difference in susceptibility to imidacloprid (IMI) between corn earworms (Helicoverpa zea) and fall armyworms (Spodoptera frugiperda). Both species belong to the Lepidoptera order and Noctuidae family, but corn earworms are significantly more susceptible to IMI. In this study, three enzyme inhibitors were used to identify the metabolic pathways that both species of moth use to detoxify IMI from their system. The enzyme inhibitors were triphenyl phosphate (TPP) which inhibits esterase, piperonyl butoxide (PBO) which inhibits mixed-function oxidases and diethyl maleate (DEM) which inhibits transferase enzymes. In the first study, we reevaluated the toxicity of imidacloprid in the presence of enzyme inhibitors by topically exposing the larvae to both the insecticide and individual inhibitors. In the second study, we crushed the larvae and assessed the activity of the metabolizing enzymes in the presence and absence of inhibitors using standardized methods. The in vitro results were observed using colorimetric assays to measure enzymatic activity. The overall outcome from this study will be incorporated into a larger project to predict insect responses to pesticides, with implications in risk assessment and pest management.

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*Lexi Baiter is a senior in Environmental Science at Missouri S&T with an interest in toxicology and its impact on environmental health. She was raised by her parents in Herculaneum, Missouri, where she saw the impacts of lead contamination that plagued her community. This experience sparked her passion for helping others through her career and research. She serves others as a Resident Assistant at Thomas Jefferson Residential Hall, and in her free time she enjoys creating expressionistic paintings.*

# Christian Bigler





Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Katie Shannon
Advisor Department: Biological Sciences



Funding Source: First Year Research Experience Program


## Effect of Dbf2 on Phosphorilation

Cytokinesis refers to the separation of two daughter cells after mitotic division. An important signaling pathway that enables this process is called the Mitotic Exit Pathway, or MEN. Of particular interest in this pathway is the Dbf2 protein kinase. Dbf2 essentially acts as a middleman within the cascade of messengers and activates proteins that physically separate the cells. The kinase activity of Dbf2 is regulated by other cellular kinases, including the cell cycle regulator kinase. Using mutant alleles of the dbf2 gene, we can manipulate this protein’ s ability to be phosphorylated or dephosphorylated, thereby altering the downstream effects of the entire MEN. After introducing the mutant alleles of Dbf2 into yeast cells, the effects of the mutations can be quantitatively observed under a microscope, since defects in cytokinesis result in “ chains” of unseparated cells.

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*Christian Bigler is a freshman undergraduate student at Missouri University of Science and Technology. He is majoring in Biological Sciences and minoring in Chemistry, and he is planning to work as a Medical Laboratory Scientist when he graduates.*

*Christian was drawn to Dr. Katie Shannon's research project on yeast cells because of its emphasis on laboratory ediquitte and skills, as well as its encumpacement of a vast array of life sciences from cell biology to genetics to biodiversity. Through working on this project, he hopes to hone his skills in laboratory science, as well as to observe fundemental biomedical methods by which the growth of cells can be regulated.*

# Greg Dreisewerd





Department: History and Social Sciences
Major: Mechanical Engineering
Research Advisor: Dr. Diana Ahmad
Advisor Department: History and Social Sciences



Funding Source: History and Social Sciences


## The History of Automobiles in the United States

In the late 19th century when automobiles first made an appearance in the United States, they were only affordable to the wealthy. Others who often could not afford the vehicles believed they were dangerous to pedestrians and causing congestion in cities. As cars became affordable to working-class individuals, they caused many positive socio-economic changes in urban and rural areas.

The research conducted for this poster compiles information from secondary books, databases, and contemporary newspapers focusing on the impact of the automobile. This poster includes data related to urban sprawl and the creation of suburban areas that were only accessible by car. There is also data pertaining to the effects of cars on rural areas, including the positive impact they had on public school attendance during the early 20th century and the increased access to centralized healthcare in hospitals and doctors' offices. In 1914, Henry Ford created what later became known as the $5 workday paying select factory workers $5 for an 8-hour workday, nearly double the normal daily wage for a factory worker of this era. Higher wages allowed Ford's workers to become the company's best customers. As a result, they became a mobile advertisement for the new vehicles. Ultimately, the automobile industry came to dominate the American culture.

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*A native of St. Louis, Greg Dreisewerd is a freshman at Missouri S&T planning to major in mechanical engineering. He is also on the school's swim team and just completed his first season. His research project for this conference is about the socio-economic impact that early automobiles had on the United States from the 1890s to the 1930s.*

**Vaughn Foreman**



Department: Chemistry
Major: Chemistry (Polymers and Coatings)
Research Advisor: Dr. Amitava Choudhury
Advisor Department: Chemistry

Funding Source: National Science Foundation

# Supramolecular Assembly of Metal Phosphates

Aluminosilicate zeolites are highly porous crystalline structures with varying properties. There are hundreds of zeolites with differing pore dimensions and channels, composed of corner-shared AlO4 and SiO4 tetrahedra. Like aluminosilicates, aluminum phosphates also form many zeolitic structures. Syntheses of zeolitic structures are often achieved in the laboratory under hydrothermal or solvothermal conditions in the presence of an organic template, which also acts as a structure directing agent.

Synthesis in high pressure bombs under hydrothermal conditions is often termed as termed as black box where aluminate, silicate, and phosphate precursors in presence of an organic amine at a certain pH spontaneously grow a three-dimensional (3-D) structure with pores and channels. However, the step-by-step building up process from the precursor primary building unit leading up to the 3-D zeolitic structures is still unknown. In this direction, we attempted to discover intermediate phases by employing much milder conditions. Such reactions have enabled us to trap structures that are one-dimensional (1-D) and built up of corner-shared polyhedra. Specifically, we will report synthesis and structure of Al and Zn doped phosphates, Al (HPO4)2[NH4][1,2 DAPH2], AlF(HPO4)(H2PO4)(DMAH2), [DMAH2]3[Zn2 (HPO4)(H2PO4)], and Zn(HPO4)2(Py).

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*Our research team has taken on the challenge of synthesizing one-dimensional metal phosphate chains through hydrothermal synthesis. We take raw materials- these being metal salts, strong acids, organic amines and under controlled temperature and volume, are able to grow these complex chains.*

*After we successfully produce the metal phosphate chains, we characterize them using Powder X-ray and Single-Crystal X-ray diffraction to measure the diffraction of high frequency waves. This shows us the thickness and coordination/shape of the layered/chain structures we produced.*

# Jennifer Harrell





Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Dr. Julie Semon
Advisor Department: Biological Sciences



Funding Source: OURE


## Assessing the Effects of Age and Sex on mTBI Severity


Traumatic Brain Injury (TBI) is a serious problem affecting soldiers in training and during deployment. Mild Traumatic Brain Injury (mTBI) accounts for over 80% of the TBIs recorded in soldiers in the last two decades. While symptoms may be mild initially,subjection to continued mTBIs could result in severe comorbidities appearing years later. Examination of current research available on mTBI shows an overwhelming skewing of murine animal models used as being solely male and of one age. With age and sex being known to have an affect on TBI, this project set out to explore the differences in severity in various age groups and genders. Using the Missouri Blast Model, a mTBI was inflicted on C57BL/6 mice with a single blast and they were monitored for 30 days. Assessment of the mice occured using the SNAP (Simple Neuroassessment of Asymmetric imPairment) Interactions test and a novel approach designed for tracking by this research team. This project showed that the affects of mTBI were identified in both the traditional SNAP assessment and with the novel tracking method. A larger difference was found between age groups than sex. Researchers were also able to show that the novel tracking method was indeed able to identify the effects of mTBI after 20 days when the traditional method was not. These results confirm the need to do further testing on differences and continue to refine the novel tracking method.


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*Jennifer is a Senior in Biological Sciences, minoring in Chemistry. Transferring in to S&T after completing her Associate's degree, Jennifer quickly became involved on campus. She's currently serving as the President of Phi Sigma Biological Sciences Honor Society and Secretary of the Equestrian Club. She's also a member of the National Society of Leadership and Success. Since coming to S&T, she has made it a habit to seek out mentorship and research opportunities on campus, being involved in three seperate projects in her two years here. In her spare time, she enjoys spending time with her children and volunteering her time to serve in leadership of their Boy Scouts of America Troop and Pack, hiking, camping, and reading. She hopes to spend her career researching Major Depressive Disorder and learning ways we can improve outcomes for those diagnosed with this disease.*

**Stephen Houser**

*Joint project with Rachel Adcock, Mercedes Lane, and Emma Puetz*



Department: Geology and Geophysics
Major: Geology and Geophysics
Research Advisor: Dr. David Wronkiewicz
Advisor Department: Geology and Geophysics

Funding Source: Geology and Geophysics Program

# Mineral Compositional Changes During Weathering

The weathering of rocks is dependent on the mineral composition, climate, and tectonic environment. Goldich (1938) determined the relative weathering rate of minerals in igneous rocks was inversely proportional to their crystallization temperature (i.e. Bowen's Reaction Series). To test this relationship, we sampled weathered and unweathered granite, rhyolite and basalt rocks from the St. Francois Mountains, MO area. The samples were crushed, pulverized, and pressed into pellets suitable for X-ray diffraction (XRD) and X-ray fluorescence (XRF) analysis. XRD and microscopic analysis showed that the K-feldspar within the granite and rhyolite samples weathered to illite and kaolinite clays. From unweathered to weathered granite, our XRF data showed there was a residual enrichment of Al (from 15 to 27 wt.%), the Si content was conserved (from 70 to 65 wt.%), the K content decreased slightly (from 6.8 to 5.1 wt.%), and the presence of Na and Mn were below detection. XRD and microscopic analysis on the basalt sample showed an unusual enrichment of K, which weathered to illite and smectite, and the presence of weathered TiO2 product, anatase. Analytical results of XRF on the basalt and rhyolite will be discussed later in the report. The purpose of this research is to observe the changes of mineral compositions during modern weathering. This can reveal how weathering processes alter over time and during climate change.

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*Stephen Houser is a sophomore in geology with a focus in exploratory geology. Stephen is an avid collector of rocks and minerals. He likes the hands on activities related to research in the geological field. This includes the gathering of smaples of rocks from mountains and lakes.*

**Mercedes Lane**

*Joint Project with Rachel Adcock, Stephan Houser, and Emma Puetz*

Department: Geology and Geophysics
Major: Geology and Geophysics
Research Advisor: Dr. David Wronkiewicz
Advisor Department: Geosciences and Geological and Petroleum Engineering

Funding Source: Geology and Geophyics Department

# Mineral Compositional Changes During Weathering

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*Mercedes Lane is a undergraduate sophomore at Missouri University of Science and Technology, studying Geology and Geophysics with a focus on planetary geology. She is employed at the Havenar food court, and is a member of the Mars Rover Design Team, designing her own rock-identifying program. She loves collecting rocks, hiking, and photography, among other hobbies.*

**Caleb Moellenhoff**



Department: Chemical and Biochemical Engineering
Major: Chemical Engineering
Research Advisor: Dr. Joseph Smith
Advisor Department: Chemical and Biochemical Engineering

Funding Source: n/a

# Designing Novel Modular Biodiesel Plant

In the search for low carbon-emitting, sustainable, and economical energy sources, biodiesel has been noted to be a potential solution. As an alternative to petroleum derived diesel, biodiesel can be produced through the transesterification reaction of waste cookiing oil and methanol. Our research has focused on scaling up this process to a commercial plant that could be placed onto a trailer allowing on-site production of biodiesel wherever waste cooking oil is made available. Our aim is that this biodiesel would meet industry quality and purity standards such that it could subsequently be used in a traditional diesel burning engine. This commerical plant design is technologically unique by virtue of four characteristics: its modular design, novel separation systems, novel reactor design, and uncatalyzed transesterification reaction that is made possible by supercritical temperatures and pressures. To formulate this design, we have developed a P&ID complete with three separation systems, one pressurized tubular reactor, and one washing step. Additionally, our P&ID also includes process controls as well as safety and environmental considerations.
From this P&ID, we are conducting a hazard and operability study, and we are also developing a 3D plant design and simulation that will enable us to analyze the sizing and cost of construction.

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*Caleb Moellenhoff is a sophomore Chemical Engineering student from Ballwin, MO. Caleb has been working with the Bioengineering & Systems Technology Laboratory team and Shyam Paudel since January. When he is not studying or doing research, Caleb enjoys running for the S&T Cross Country and Track team, being involved in Christian Campus Fellowship, reading, and playing the piano.*

# Elizabeth Nolte





Department: Electrical and Computer Engineering
Major: Computer Science
Research Advisor: Dr. Mina Esmaeelpour
Advisor Department: Electrical and Computer Engineering



Funding Source: N/A


## Simulation of a Photonic Crystal Fiber

The importance of optical fibers has been greatly increasing over the years as technology for communication and sensing continues to improve and expand. With this increased importance, there has been more research into optimizing optical fibers to make them more sensitive and reliable, which is especially important for biosensing. One of the types of fibers being studied is the photonic crystal fiber, which contain a pattern of holes in their cross-section. In this study, various simulations will be done using the RSoft software to compute the modes of a photonic crystal fiber.

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*Elizabeth Nolte is a first-year student planning to major in computer science at Missouri Science & Technology. She is from St. Louis, Missouri. She received the National Merit Semifinalist Scholarship Package. She is currently learning and working as an intern in the fiber optics lab run by Dr. Esmaeelpour.*

**Emma Puetz**

*Joint project with Rachel Adcock, Stephan Houser, and Mercedes Lane*

Department: Geology and Geophysics
Major: Geology and Geophysics
Research Advisor: Dr. David Wronkiewicz
Advisor Department: Geology and Geophysics



Funding Source: Geology and Geophysics Department

# Mineral Compositional Changes During Weathering

The weathering of rocks is dependent on the mineral composition, climate, and tectonic environment. Goldich (1938) determined the relative weathering rate of minerals in igneous rocks was inversely proportional to their crystallization temperature (i.e. Bowen's Reaction Series). To test this relationship, we sampled weathered and unweathered granite, rhyolite and basalt rocks from the St. Francois Mountains, MO area. The samples were crushed, pulverized, and pressed into pellets suitable for X-ray diffraction (XRD) and X-ray fluorescence (XRF) analysis. XRD and microscopic analysis showed that the K-feldspar within the granite and rhyolite samples weathered to illite and kaolinite clays. From unweathered to weathered granite, our XRF data showed there was a residual enrichment of Al (from 15 to 27 wt.%), the Si content was conserved (from 70 to 65 wt.%), the K content decreased slightly (from 6.8 to 5.1 wt.%), and the presence of Na and Mn were below detection. XRD and microscopic analysis on the basalt sample showed an unusual enrichment of K, which weathered to illite and smectite, and the presence of weathered TiO2 product, anatase. Analytical results of XRF on the basalt and rhyolite will be discussed later in the report. The purpose of this research is to observe the changes of mineral compositions during modern weathering. This can reveal how weathering processes alter over time and during climate change.

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*Emma Puetz is a junior at Missouri S&T majoring in Geology, with a focus in Paleontology, and minoring in French. She is the Secretrary of C.L Dake Geological Society and an athlete on the S&T Women's Cross Country and Track teams. She is also an Undergraduate Research Assistant in a Materials Department Lab. Her hobbies include running, hiking, travelling, and spending time with her friends and family.*

**Amberly Scott**

*Joint project with John Sneed and Kathryn Zychinski*



Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Dr. Niranjana Krishnan
Advisor Department: Biological Sciences

Funding Source: Missouri S&T

# Insecticide Metabolic Responses of Two Lepidoptera

Soybean loopers (Chrysodeixis includens) and corn earworms (Helicoverpa zea) are moth pests of soybean and corn fields across the United States, including Missouri. Here, we assessed their toxic and metabolic responses to cypermethrin, a pyrethroid insecticide registered for foliar use in agriculture.

An analysis of literature studies and generation of preliminary dose-response curves in the laboratory indicated that, although corn earworms and soybean loopers belong to the same lepidopteran family (Noctuidae), they show different susceptibilities to topically applied cypermethrin. To assess if metabolic factors are responsible for these differences, we undertook synergistic studies with PBO, TPP, and DEM, which are the inhibitors of three major detoxifying enzymes in the insect body: cytochrome P450s, esterases, and glutathione-s-transferases. We also measured the activity of the detoxifying enzymes through standardized assays.

Findings from this research will be incorporated into a larger project with the goal of identifying surrogate (pest and non-target) species for testing and elucidating differences in susceptibilities. This is necessary to accurately estimate toxic responses within and across taxonomic orders.

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*Amberly Scott is a junior at Missouri University of Science and Technology majoring in Biological Sciences while minoring in Chemistry. She is the philanthropy and open lab chair officer of Helix Club, as well as a member of the National Society of Leadership and Success. Her academic interests include toxicology and biopharmaceuticals.*

**John Sneed**

*Joint project with Amberly Scott and Kathryn Zychinski*

Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Dr. Niranjana Krishnan
Advisor Department: Biological Sciences

Funding Source: Missouri S&T

# Insecticide Metabolic Responses of Two Lepidoptera

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---

*John Sneed is a senior transfer student at Missouri University of Science and Technology majoring in Biological Sciences with a Pre-Medicine emphasis and a minor in Chemistry. He is also completing his associates degree in Liberal Arts at Austin Peay State University in Clarksville, TN. At Missouri S&T, he is the Vice President of National Society of Leadership and Success, the Secretary of Phi Sigma Biological Honor Society, a Representative of Student Council, a member of the Science Olympiad Alumni chapter, and a member of SCRUBS. Before transferring from APSU, he was the Social Enrichment Officer at APSU's chapter of the Alpha Lambda Delta Honor Society. His academic interests include biochemistry, toxicology, and microbiology.*

**Maya Washington**



Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Julie Semon
Advisor Department: Biological Sciences

Funding Source: None

# Effects of Autoimmune Disease on MSCs

Mesenchymal stem cells, or MSCs, are pluripotent adult stem cells capable of producing daughter cells with more than one fate as well as performing self-replication. Their ability to self-renew and create cells from all three germ layers gives them a variety of uses within regenerative medicine and tissue engineering, including modulation of autoimmune diseases. Despite their promising pre-clinical studies, results in clinical trials are less effective. Our hypothesis is that MSCs are defunct in autoimmune disease and treatment, therefore, requires the use of allogenic MSCs instead of autologous, which is currently the standard. Autologous MSCs that are isolated from a patient suffering from autoimmune disease and then reintroduced to that same patient will not be able to initiate regeneration as effectively as allogeneic stem cells, which are MSCs that are isolated from a healthy donor and then transplanted to an unhealthy patient. The aim of this project is to: 1) ascertain the effects that autoimmune diseases have on MSCs, 2) identify biomarkers in incompetent MSCs, since we also hypothesize that autologous MSCs from autoimmune patients will contain differentially expressed genes in comparison to competent MSCs.

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*Maya Washington is a senior in biological sciences with minors in chemistry and psychology. She is a short sprinter on the Track and Field team at S&T as well as the president of Rolla Students for Life and the secretary of the National Society of Leadership and Success. After graduation, Maya plans to pursue a career in medicine as a medical doctor.*

**Sage Wood**
*Joint Project with Lexi Baiter*



Department: Biological Sciences
Major: Biological Sciences, Environmental Sciences
Research Advisor: Niranjana Krishnan
Advisor Department: Biological Sciences

Funding Source: FYRE, Missouri S&T Biological Sciences Department

# Enzyme Inhibitors and Insecticide Effect on Caterpillars

This project aims to determine why there is a significant difference in susceptibility to imidacloprid (IMI) between corn earworms (Helicoverpa zea) and fall armyworms (Spodoptera frugiperda). Both species belong to the Lepidoptera order and Noctuidae family, but corn earworms are significantly more susceptible to IMI. In this study, three enzyme inhibitors were used to identify the metabolic pathways that both species of moth use to detoxify IMI from their system. The enzyme inhibitors were triphenyl phosphate (TPP) which inhibits esterase, piperonyl butoxide (PBO) which inhibits mixed-function oxidases and diethyl maleate (DEM) which inhibits transferase enzymes. In the first study, we reevaluated the toxicity of imidacloprid in the presence of enzyme inhibitors by topically exposing the larvae to both the insecticide and individual inhibitors. In the second study, we crushed the larvae and assessed the activity of the metabolizing enzymes in the presence and absence of inhibitors using standardized methods. The in vitro results were observed using colorimetric assays to measure enzymatic activity. The overall outcome from this study will be incorporated into a larger project to predict insect responses to pesticides, with implications in risk assessment and pest management.

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*Sage Wood is a first-year Biological Sciences major at Missouri S&T interested in using insects as indicators of environmental health. They are constantly searching for new ways to learn and improve themself, both in the field of entomology and in their role as a student leader. Sage is from Jefferson City, Mo, where their parents and younger sister reside. They are very involved in campus life and in their residence hall association. They also play the cello with the university symphony and in musical theater productions.*

**Kathryn Zychinski**
*Joint project with Amberly Scott and John Sneed*



Department: Biological Sciences
Major: Biology and Physics Double Major
Research Advisor: Dr. Niranjana Krishnan
Advisor Department: Biological Sciences

Funding Source: Missouri S&T

# Insecticide Metabolic Responses of Two Lepidoptera

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Findings from this research will be incorporated into a larger project with the goal of identifying surrogate (pest and non-target) species for testing and elucidating differences in susceptibilities. This is necessary to accurately estimate toxic responses within and across taxonomic orders.

---

*Kathryn Zychinski is a lab assistant for Dr. Krishnan Niranjana's lab at Missouri Science and Technology where they and two other lab members have begun researching the metabolic responses of two lepidopteran species to a commonly employed insecticide. As of 2022, they are a sophomore-level undergraduate here at Missouri S&T with plans to double major in both Biology and Physics along with minoring in pre-medicine. They are an active member of the Missouri S&T Honors Academy and the Spectrum club, and their academic interests lie in the field of neurology.*

# OURE Fellows Proposal Oral Applicants 2022-2023

## Thursday – April 14, 2022

| Name | Department | Time | Location |
|---|---|---|---|
| Gabrielle Hightower | Biological Sciences | 10:00-10:30am | Missouri |
| Dylan Johnson | Biological Sciences | 10:30-11:00am | Missouri |
| Megan Percy | Chemistry | 11:00-11:30am | Missouri |

# Oral Fellows Final Oral Presentation 2021-2022

## Thursday – April 14, 2022

| Name | Department | Time | Location |
|---|---|---|---|
| Derrick Barger | Mechanical and Aerospace Engineering | 9:00-9:30am | Ozark |
| Gabrielle Hightower | Biological Sciences | 9:30-10:00am | Ozark |
| Alex Daniels | Biological Sciences | 10:00-10:30am | Ozark |
| Gladwin Labrague | Chemistry | 10:30-11:00am | Ozark |
| Sara McCauley | Chemistry | 11:00-11:30am | Ozark |
| Ethan Prior | History and Political Science | 11:30am-12:00pm | Ozark |

# OURE Fellows Program

# Oral Abstracts

# Applicants

# Gabrielle Hightower





Department: Biology
Major: Biology and Psychology
Research Advisor: Dave Westenberg
Advisor Department: Biology



Funding Source: OURE Fellows and EPA


## The Use of Nanoparticles and Bioglass in Inhibiting Legi


Legionnaires' disease is a form of pneumonia caused by coming into contact with Legionella pneumophila. Exposure typically occurs when humans use showerheads, sink faucets, or large plumbing systems that the bacterium has colonized. This public health crisis has led researchers to find ways to help eradicate Legionella from these water systems, however many of the current methods are not sufficient in preventing recolonization and can lead to corrosion of water pipes. Given this, the project at hand aims to use two different methods to tackle this issue. The first method involves testing copper nanoparticles as a viable alternative to these solutions by determining the concentration and ideal size of nanoparticles needed to kill the bacteria. Additionally, we will use bioglass doped with anti-bacterial metals to test its effectiveness in inhibiting biofilm formation by the bacteria. All studies will be conducted using an avirulent strain of the bacteria (LP02).


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*Gabrielle Hightower is a junior from Kansas City, Missouri majoring in Biology and Psychology. She has participated in Missouri S&T's FYRE, OURE, and OURE Fellows programs as well as the Summer Undergraduate Research Fellowship through the University of Arkansas for Medical Sciences. She plans on using this experience once she graduates to obtain her PhD and conduct research. When she is not conducting research, she is an active member of Chi Omega, Missouri S&T Ballet and Dance Club, Blue Key, and SCRUBS.*

# Dylan Johnson





Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Robin Verble
Advisor Department: Biological Sciences



Funding Source: Missouri S&T


## Foraging For Non-Food Items in Harvester Ants

Several species of harvester ants have been observed regularly foraging for non-food items such as bits of charcoal and placing them around the entrance to the colony. These behaviors are well-documented, but the reason remains unclear. Thermoregulation and sanitation are two prevailing theories, although research into these factors have proven inconclusive in the past. This project seeks to investigate these behaviors and determine whether there is a purpose behind this foraging habit, or whether it is simply an evolutionary quirk.

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*Dylan Johnson is entering his fourth year in the Biological Sciences program, with an emphasis on Secondary Education. He has worked on several projects in Dr. Verble's lab, including Berlese extraction methodology and acorn growth rates. Most recently, Dylan participated in a 6 week long research fellowship conducting an insect diversity survey for the environmental department in Fort Leonard Wood. Outside of the lab, Dylan was involved in Residential Life as a Resident Assistant and is currently working alongside high school teachers in local schools to prepare for student teaching.*

**Megan Percy**



Department: Chemistry
Major: Chemistry
Research Advisor: Manashi Nath
Advisor Department: Chemistry

Funding Source: National Science Foundation & ACS Petroleum Research Fund

# Chalcogenide Nanomaterials as Biosensors

Chalcogenide nanomaterials have recently been found to have various electrochemical properties that allows them to oxidize biomolecules such as uric acid, ascorbic acid, dopamine, and glucose. This direct oxidation process lets off electrons that allow such biomolecules to be detected and measured with high precision and accuracy. Producing these nanomaterials as electrochemical biosensors could have many benefits to the public, including but not limited to reusability, a longer shelf life of the product than current enzyme-based biosensors, higher sensitivity, and possible integration into continuous health monitoring devices.

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*Megan Percy is a second year student at Missouri Univeristy of Science and Technology, majoring in Chemistry with an emphasis in Biochemistry, and pursuing a minor in Biomedical Engineering. She is originally from St. Peters, Missouri, and, in addition to conducting research under Dr. Manashi Nath, she is a member of the social sorority Zeta Tau Alpha, working for their philanthropy team as the Public Relations chairman.*

# OURE Fellows Program

# Oral Abstracts

# Final

# Derrick Barger





Department: Mechanical Engineering
Major: Mechanical Engineering
Research Advisor: Dr. Jonghyun Park
Advisor Department: Mechanical Engineering



Funding Source:


## Modeling Li-ion Battery Temperature and Degredation

An ideal battery model must gather sufficient electrochemical data about the battery system while remaining computationally efficient. To prevent failure from thermal runaway and protect the battery health, understanding the thermal characteristics of a battery throughout its lifespan is essential, particularly for 3D applications in a battery pack.

To achieve this, a single particle battery model was coupled with a 3D heat generation component to simulate the heat generation and 3D heat transfer in a cell. Mathematical modeling equations were used to predict the growth of the solid electrolyte interphase (SEI) layer, the primary contributor to degradation. This cell model was applied to a 6-cell pack to observe pack heat transfer during degradation.

To validate this model, a 6-cell battery pack was created and tested experimentally. From this experimental data, parameter estimation was performed to understand the composition of each cell. This pack was then recreated and simulated to provide a reference for the battery model.

The results indicate a parabolic SEI thickness growth when cycling. This resulted in non-linear capacity loss, and due to the corresponding increase in cell resistance from SEI growth, the heat generation increased as the battery degraded. The 3D pack temperature was highest at the center of the pack due to heat transfer with surrounding cells.

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*Derrick Barger is a senior mechanical engineering student that is passionate about reducing humanity's reliance on fossil fuels. He has conducted research focused on battery modelling and simulation under the guidance of Dr. Jonghyun Park since the spring of 2020. Derrick became interested in this project because of the unique challenges associated with engineering in extreme temperature environments, particularly ultra-cold environments. After learning about the research process as an undergraduate student at Missouri S&T, he plans on pursuing his master's degree in cold climate engineering at the Arctic University of Norway in Tromso.*

# Alex Daniels





Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Dr. David Westenberg
Advisor Department: Biological Sciences



Funding Source: Biological Sciences Department


## Biosensor Strain Construction

The purpose of this study is to create a method to determine the modality in which E. coli bacteria is damaged through the application of metallic nanoparticles. By constructing a  biosensor strain of E. coli. The form of damage can be determined based on the hypothesis that when the cell is damaged, a bioluminescence will occur as a product of the promoterless lux operon which has been fused within the induction of a biosensor promotor which has been fused to the lux operon . Previous experiments have successfully constructed such a biosensor for the purpose of determining antibiotic damage modality, however in this experiment, the successful construction of a biosensor is the intention to be used in a future examination of the effects of metallic nanoparticles on an E. coli biosensor strain. In turn, these effects will be analyzed for the eventual purpose of nanoparticle use in the medical field as a disinfectant and bacterial infection treatment as opposed to antibiotics which bacteria are gaining resistance to.

---

*Alex Daniels grew up in the small town of Troy, Missouri and moved to Rolla in 2019. Presently, she is a senior at Missouri S&T working towards her Bachelor's of Arts in Biological Sciences with an emphasis in Secondary Education and a minor in Psychology. She has worked on several undergraduate research projects including "The Effects of pH on Bacterial Growth," "Application of Copper Nanoparticles to Legionella Bacteria," and her current project, "Biosensor Strain Construction." Alex is active in the Residential Life and Education Department here on campus and plans to work in the research industry before moving into teaching.*

# Gabrielle Hightower





Department: Biology
Major: Biology and Psychology
Research Advisor: Dave Westenberg
Advisor Department: Biology



Funding Source: OURE Fellows and EPA


## Quantifying Nanoparticle Toxicity in Bacterial Cells


Pneumonia can come in all shapes and sizes. One form called Legionnaires' disease results from the Legionella pneumophila bacterium that contaminates water sources used by humans. The goal of this project is to find out the effectiveness of using copper nanoparticles to eradicate these bacterial colonies from pipes, showerheads, and other water reservoirs in order to reduce the likelihood of developing this form of pneumonia. The aim was to determine the concentration of nanoparticles that was the most effective in killing an avirulent strain of the bacteria (LP02) by performing serial dilutions, reading the OD600, and plating the dilutions to estimate colony counts. The results of this project indicate that the ideal concentration of nanoparticles for eliminating LP02 from the suspension is around 1:2000 ul/ml dilution.


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*Gabrielle Hightower is a junior from Kansas City, Missouri majoring in Biology and Psychology. She has participated in Missouri S&T's FYRE, OURE, and OURE Fellows programs as well as the Summer Undergraduate Research Fellowship through the University of Arkansas for Medical Sciences. She plans on using this experience once she graduates to obtain her PhD and conduct research. When she is not conducting research, she is an active member of Chi Omega, Missouri S&T Ballet and Dance Club, Blue Key, and SCRUBS.*

# Gladwin Bryan Labrague





Department: Chemistry
Major: Chemistry
Research Advisor: Thomas Schuman
Advisor Department: Thomas Schuman



Funding Source: N/A


## Reactivation of Inhibited Modified Portland Cement


Concrete has been used extensively as a foundational structural material for construction because of its relatively higher strength, high durability, facile fabrication, and better noncombustibility properties as compared to other materials. Portland cement is one of the commonly used binder materials in concrete matrices. Last academic year, the student ′s research group found compounds that can inhibit the hydration of Portland cement for at least eight hours. This 2021-2022, the group attempted to reactivate the retarded Portland cement using different chemical species. It was found that acidic species have no significant contribution in reactivation while some salts were able to reactivate the retarded Portland cement. Addressing reactivation of Portland cement hydration is necessary in the construction industry because it could allow companies to set cement when desired. Reactivating the hydration is also useful in wet conditions when a cement is at risk of being washed off immediately.


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*Glad is a senior studying chemistry emphasizing in Polymers and Coatings Science. He has been doing research since 2019 in the Department of Chemistry. He also works as a tutor at the Student Success Center, where he mainly tutors chemistry. In his free time, he plays tennis and watch anime.*

**Sara McCauley**



Department: Chemistry
Major: Chemistry
Research Advisor: Dr. Rainer Glaser
Advisor Department: Chemistry

Funding Source: OURE Fellows of Missouri S&T

# Low-Cost Colorimetric Applications in 2e Education

Educational inequality runs rampant in Missouri secondary education. At the root of this problem lies a lack of funding for rural and impoverished school districts. Colorimetry can be used in low-cost experiments that might otherwise be inaccessible to certain classrooms. We have developed a colorimetric method of determining the concentrations of colored analytes, and we apply this method to the traditional acid/base titration experiment using free user-friendly software. We will report results of two titration setups: a weak acid/strong base titration with phenolphthalein indicator, and a weak base/strong acid titration with methyl red indicator. The results of the colorimetric method will be compared with pH titration curves as well as kinetic simulations and UV-Visible spectroscopy. We will establish the experimental error in the colorimetric method and compare the merits and deficiencies of the various methods. We will also discuss methods of outreach and make recommendations to educators implementing this experiment.

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*Sara McCauley is a senior in Chemistry with a degree emphasis in polymers and coatings. She has been doing undergraduate research with Dr. Rainer Glaser since the Fall of 2018, and her work focuses on the kinetics and mechanism of Belousov-Zhabotinsky oscillating reactions. In parallel, she has developed and validated an analytical colorimetric method, and is pursuing applications of the method in fields such as education and psychology. In the future, she hopes to pursue a graduate degree in Chemistry, focusing on research in polymers and coatings.*

# Ethan Prior





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Funding Source: Personal Resources and Advisor's Faculty Support Account


## The Art of Rebellion

The fall of the Berlin Wall in 1989 will always bring to mind the destruction of its colorful walls of concrete panels. The imagery of people slamming the wall with sledgehammers and pickaxes seems to speak loudly to what the people of Berlin thought about the wall. But what about the other decades within the Wall's nearly thirty-year existence? What did the citizens of Berlin think about the wall then? One way to answer these questions is to use the graffiti found on the wall.

The graffiti on the Berlin Wall, when analyzed, can be separated into four different eras: The Era of Minimal Graffiti (1961-1977), The Era of Political Graffiti (1978-1982), The Era of Artistic Graffiti (1983-1989), and the Era of Memorialization Graffiti (1989-Present). Different locations where the wall stood (or is standing), like Bernauer Strasse, Zimmerstrasse, Potsdamer Platz, and Westminster College all show what these different eras represent and how they show the relationship between the oppressed and the oppressive wall. Case studies from the wall, like the graffitied statement "Freiheit für Weinhold", also help to give an in depth look into how these eras help to show the relationship between the wall and the civilians in its shadows.

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*Ethan Prior is a senior working on a B. A. in history at the Missouri University of Science and Technology. After graduation, Ethan plans on moving forward to earning a masters and doctorite in history, with hopes on becoming a professor.*

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