Welcome to the 2018 EUREKA! Poster Forum. EUREKA! (Experiences in Undergraduate Research, Exploration and Knowledge Advancement) is a unique endeavor to immerse incoming Calhoun Honors College students into the academic world of Clemson University. From June 28th through August 4th, students performed their research, explored the campus and its many facilities, got acquainted with some of the university’s best faculty and administrators, and experienced the diverse culture and natural beauty of Upstate South Carolina.
Based on an idea conceived by Dr. Stephen H. Wainscott, Director of the Calhoun Honors College, and further developed by a committee of the following members:

Dwight Camper, Professor of Entomology, Soil, and Plant Science  
Dana Irvin, Assistant Director of the Calhoun Honors College  
Pam Mack, Associate Professor of History  
James McCubbin, Professor and Chair of Psychology  
Mary Miller, Special Assistant to the Provost  
Gary Powell, Professor Emeritus of Genetics and Biochemistry  
Steve Wainscott, Director of the Calhoun Honors College  
Sean Williams, Associate Chair and Professor of English  
Bill Pennington, Professor of Chemistry

a new program, “Experiences in Undergraduate Research, Exploration and Knowledge Advancement!” (EUREKA!), was created in 2006.

During the second summer session of 2018 the thirteenth group of EUREKANS!, consisting of thirty-four incoming Honors freshmen, representing eleven different states, and three continuing Honors College students serving as counselors, arrived on campus for a five-week period of research, scholarship, and discovery. Students worked on individual projects under the direction of faculty mentors in fields ranging from the social sciences and humanities to natural and physical sciences and engineering. In addition to their research activities the participants attended workshops, seminars and field trips on various topics designed to orient them to academic life on campus and provide them with the basic skills needed to perform research in a broad range of areas. The EUREKANS! also became acquainted with the surrounding area through a variety of social activities, such as camping and whitewater rafting on the Nantahala River, a Greenville Drive baseball game, and trips to the Aquarium and Stone Mountain in Atlanta and Carowinds in Charlotte.

In addition to the educational rewards of active participation in undergraduate research, the students got to know the campus and interacted with many faculty, staff, administrators, and other students. They developed networks of supportive mentors and colleagues that will serve them well in their academic careers. It is hoped that they will continue their projects, and that their enthusiasm for research will encourage their peers to follow their lead to build an exciting and productive environment for undergraduate research, scholarship and discovery at Clemson University.

2018 EUREKA! Student Participants

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Optimizing Silica Coated Magnetic Nanoparticles for Biomedical Applications

Will Cotterman, Daniel Turner, and O. Thompson Mefford
Department of Material Science and Engineering, Center for Optical Materials Science and Engineering Technologies, Clemson University

Magnetic nanoparticles (MNP’s) have been explored for biomedical applications such as antibiotics, cancer therapy, drug delivery, and MRI imaging. MNP’s must therefore be dispersible in water, stable in physiological relevant pH’s and salinities, and able to be selectively modified for a variety of functionalities. The current method used to achieve these properties is a long, complicated process of ligand exchange. However, coating MNP’s in a silica shell is an alternative process proven to result in these desired properties. Advantages of using silica are that: silica chemistry is well-known, a silica coating improves MNP biocompatibility, and MNP’s with a silica coating are easy to chemically modify. The purpose of this project was to replicate and refine a silica coating procedure, characterize the resulting particles, and tailor their properties to use for further polymer modification. While silica coated MNP’s were successfully synthesized in three separate sets of reactions during this research project, and had good colloidal stability, the resulting particles were inconsistent. They tended to aggregate in solution and had uneven distribution of silica. Future work should be directed at further adjusting reaction conditions to achieve optimal properties.

Genetic Engineering of Yarrowia lipolytica to Increase Lipid Production

Anna Delahunt, Allison Yaguchi, Meredith Bailey, Mark Blenner
Department of Chemical and Biomolecular Engineering, Clemson University

Triacylglycerols (TAGs) are essential components of many industries, such as biofuels and nutrition. Yarrowia lipolytica naturally accumulates these lipids; however, their commercial use is limited by the inhibition of other intermediates and being diverted into membrane biogenesis. Utilizing genetic engineering techniques, the goal of this project was to overcome these obstacles by overexpressing three genes. The first, diacylglyceride acyl-transferase (DGA1), drives the reaction towards TAG storage, while the other two, stearoyl-CoA desaturase (SCD) and acetyl-CoA carboxylase (ACC1), convert inhibitors. Through the transformation of this plasmid, it was expected that the flux of the reaction would be pushed towards producing more TAGs. Three different strains were tested. One strain was used as a wild type control, one halted activity of the β-oxidation pathway to prevent lipid degradation, and one strain eliminated peroxisomes, the organelle where β-oxidation occurs. During the project, only SCD and DGA1 were able to be introduced into a new plasmid for episomal expression; however, future work includes cloning and integrating ACC1 as well. Greater accumulation of TAGs in these yeast will make them more viable options for industry use.
DNA Repair and Genome Instability

Jessica Den Haese, Katerina Terwelp, Garrett Buzzard, Steven Goodson, Dr. Michael G. Sehorn
Department of Genetics and Biochemistry, Clemson University

The protein complex Mei5-Sae3 acts as a mediator to promote nucleation of Dmc1 recombinase onto single-stranded DNA during meiotic homologous recombination (HR). This research is focused on the yeast Mei5 protein and its ability to bind DNA. The goal of our research is to determine the role of the 58th and 59th amino acids in the DNA binding activity of yeast Mei5 by substituting them with other residues, with the intention of inhibiting Mei5’s ability to bind to ssDNA. This allows us to examine whether this ability to bind DNA is necessary for initiating Dmc1 assembly in a biochemical setting using our mutant Mei5 protein.

The Role of Citrate in Low-Dosage Radiation Experiments

Keller Brogdon, Molly Wintenberg, Lisa Manglass, and Dr. Nicole Martinez
Department of Environmental Engineering and Earth Sciences, Clemson University

The work described herein is part of a larger project focused on developing a biosensor capable of detecting and discerning clandestine nuclear activities. This type of biosensor is advantageous as it could be left unattended and could also provide a lasting record of radiation exposure. The current experiment seeks to gain insight into and provide refinement for previous results.

Citrate is a necessary ingredient in the bacterial cultures to ensure the radioactive material stays in solution. However, one of the species used in this experiment, *Pseudomonas putida*, can use citrate as a food source. In some previous experiments, we saw evidence of plutonium uptake in *P. putida*, but not *E. coli*. We had further questions about this phenomenon, such as if there is a time-dependence or if citrate affects the rate of uptake. Therefore, we compared DNA damage in *E. coli* against that in *P. putida*, as *E. coli* cannot consume citrate, as well as testing with and without the presence of citrate. In order to do so, we performed a dPPH assay as well as a liquid scintillation count to measure the extent of the damage done to the bacterial DNA.
Using Atomic Force Microscopy to Image Metal Sulfide Nanoparticles

Martin Driggers, Tatiana Estrada-Mendoza, and Professor George Chumanov
Department of Chemistry, Clemson University

This research project is focused on the use of Atomic Force Microscopy (AFM) to image metal sulfide nanoparticles. The nanoparticles were synthesized in a solution by reacting metal salts with sodium sulfide in the presence of a silica matrix and have the potential for many applications including electronics, photovoltaics, and biomedical diagnostic. With the right concentrations of sulfur, silica, and metal ions, non-aggregated metal sulfide nanoparticles can be synthesized in an aqueous solution, stabilized by silica. The size of the nanoparticles can range anywhere from 10 nm to 500 nm depending on the concentrations of reactants. AFM was utilized to determine their size and morphology because it is readily available and can producing quality images. The AFM samples were prepared by a simple drop-casting method of nanoparticle suspensions. Copper sulfide, tin sulfide, silver sulfide, and zinc sulfide nanoparticle samples were imaged during the research. While some nanoparticles aggregated during drop-casting, many remained distinct with near-uniform size distribution, thereby demonstrating that this nanoparticle synthesis method is consistently successful, and AFM is an appropriate and applicable technique for their imaging.

Manipulating G. xylinus with Dielectrophoresis to Create Meaningful Structures

Quin Kieu, Devin Keck, Dr. Rodrigo Martinez-Duarte
Multiscale Manufacturing Laboratory, Department of Mechanical Engineering, Clemson University

Gluconacetobacter xylinus, a cellulose-producing bacterium, creates bacterial cellulose which is superior to plant cellulose in purity and mechanical strength. G. xylinus extrude at random leading to cellulose with no meaningful structure. Deliberate patterning would allow utilization of the advantages of bacterial cellulose. The following experiments characterize the attraction of G. xylinus to specific locations using dielectrophoresis (DEP). DEP is the force induced on dielectric particles when they are exposed to a non-uniform electric field. Positive DEP, or attraction, can be utilized to trap G. xylinus. Straight cellulose fibers may then be produced in a continuous flow of media as the cellulose is extruded in the direction of the flow. We began the characterization of the DEP response of G. xylinus in different electric fields in multiple media that varied in nutrients and conductivity at a constant voltage of 20 Vpp with AC currents ranging from 62.5 kHz - 20 MHz. Positive DEP was not shown in media above 40% concentration of nutrients due to higher conductivities. The strongest responses were seen above 1 MHz. Currently, the aim is to devise a media that balances cellulose production and attraction with DEP. Future work is focused on fully characterizing the DEP response of G. xylinus.
Development of DPA-6002 Antimicrobial

Allyson Drawdy, Geoffrey Chesser, & Dr. Dev P. Arya
Department of Chemistry, Clemson University

Over time, numerous bacterial strains have become resistant to traditional antibiotics such as Penicillin and Cephalosporins, calling for the development of new antimicrobials. DNA Topoisomerase I is an enzyme that is responsible for regulating DNA topology and contains properties that can be utilized to develop antibacterial agents. This study focuses on the development of DPA-6002 (a morpholino Hoechst 33258 derivative), created by an eight-step series of synthesis reactions. The production of DPA-6002 is geared toward the inhibition of DNA Topoisomerase I in the hopes of ultimately eradicating the targeted strain of bacteria. After each step of the synthesis reaction, a new molecule with a varied linker was collected to become the reagent of the next step of the reaction, until ultimately deriving the final product of DPA-6002 in step eight. Evidence of the presence of the compound within each step and verification of molecular composition was obtained by analyzing the results of a 1H NMR along with a MALDI spectrum. Antibiotic resistance is expected to kill ten million more people than cancer by the year of 2050, thus emphasizing the importance of the race to discover new antimicrobial compounds such as DPA-6002.

Cloning of Candidate Stress Response Genes from Paspalum vaginatum

Inara Devji, Charles Henry, Joshua Stapleton, Sarah Powers, Dr. Zhigang Li, Dr. Hong Luo
Department of Genetics and Biochemistry, Clemson University

Abiotic stress, such as high salinity, has a negative effect on the ability of crops to grow and take in water. It is estimated that at least 20% of the world’s cultivated land is impaired by salinity, with more and more viable land lost each year due to changing environments. Plants that grow in tropical and coastal regions, such as seashore paspalum (Paspalum vaginatum), are very salt tolerant. The purpose of this study is to clone seashore paspalum candidate genes potentially involved in plant salt stress response and study their function in transgenic plants so that they can be used in crop species for enhanced salt tolerance. We have chosen five genes that exhibited high differential expression between normal and stressful conditions, with the m.11 being successfully cloned. PCR, gel electrophoresis, bacterial transformation, colony and RACE PCR were some of the techniques used during the experiment. After sequencing and a BLAST search, the m.11 gene has been related to the WRKY genes family, known to be involved in abiotic stress response. If transgenic plants overexpressing m.11 begin to demonstrate increased tolerance to salt, then it is clear that the m.11 gene is indeed involved in plant response to abiotic stress. Introducing a gene that increases plant resilience would allow a more diverse set of growth environments for crop production.
Effect of Radiological and Endocrine-Disrupting Contaminants on Seed Growth

Cody Eimen, Lisa Manglass, Molly Wintenburg, Dr. Nicole Martinez
Department of Environmental Engineering, Clemson University

The increasing use of nuclear medicine treatments and synthetic estrogen for both humans and livestock provides a pathway for radiological and endocrine-disrupting contaminants to the environment, both alone and in combination with one another. In order to investigate the effects of synthetic estrogen and radiological exposure, an experiment was conducted using Arabidopsis thaliana seeds. Seeds were germinated and grown for 14 days on agar plates spiked with 17α-ethynylestradiol (synthetic estrogen, EE2), tritium (3H), plutonium-239, and combinations of EE2 with each of the two types of radiation. Although 3H and 239Pu are not specifically medical isotopes, they can nonetheless provide representative results for other beta and alpha emitting radionuclides. The study investigated root length, lateral root growth, and leaf color of sprouted seeds to assess overall plant health. Germination and growth of seeds exposed to the different sets of environmental stressors were compared to a control group. The root length assessment of the seeds showed the greatest reduction in root growth with the combination of estrogen and plutonium. The contamination that least stunted the root length was just estrogen alone.

Anti-cancer and Anti-inflammatory Capacities of Plant-derived Compounds

Tracey Gartner, Luke Broughton, Hui Ding, Dr. Yanzhang Wei
Department of Biological Sciences, Clemson University

P. peruviana L., the Poha Berry, has exhibited the potential to inhibit cancer cell proliferation and/or inflammation. Several compounds from the plant have been determined and purified for testing. Accordingly, the objective of our study is to explore the potential anti-cancer and/or anti-inflammatory activity of the aforementioned compounds. MTS proliferation assay was utilized to assess the anti-cancer activity of the compounds on human cervical carcinoma line HeLa. To measure the anti-inflammatory activity of the compounds, a Griess reagent assay for Nitric Oxide (NO) production was performed on mouse macrophage line RAW 264.7, following stimulation by lipopolysaccharides (LPS). Several dosages of each compound were applied to both cell samples to analyze the relationship between the compound and cell proliferation and/or NO production. The results of the MTS assay exhibited that all samples except 72-2 and 75-1 displayed anti-cancer activities. Additionally, all samples except for the 10 μg/mL treatment of 72-1 and either concentration of sample 72-2 exhibited anti-inflammatory activities. These compounds derived from the Poha Berry may hold the capacity to serve as a drug for cancer and/or inflammation in the future.
Dynamics of the Formation of Copper Nanoparticles During the Pyrolysis of Cellulose

Bailey Gibson, Paige Reed, Dr. Carlos Garcia
Department of Chemistry, Clemson University

Although numerous materials can be used for the development of biosensing devices, carbon is one of the most popular electrode materials [1][2]. The biocompatibility, stability and durability, sensitivity, and cost of most carbon materials are vital to the future of the rapidly expanding biosensing field [1]. In this regard, our laboratory has recently demonstrated that carbon electrodes fabricated by pyrolysis of paper can be efficiently used to develop biosensors. While it is also known that their catalytic properties can be greatly enhanced by the inclusion of copper nanoparticles, the formation mechanism and the role of the substrate on the reduction reaction is currently unclear. Aiming to address this gap in current knowledge, the purpose of this project was to determine the temperature at which nanoparticles are formed when a solution of CuSO$_4$ was used to soak a paper substrate. Though CuSO$_4$ has a relatively low melting point and boiling point (110°C and 250°C respectively), it does not decompose into CuO$_2$, SO$_2$, and O$_2$ until approximately 650°C [4]. Therefore, the temperature range required to observe the formation of copper nanoparticles was expected to be around 400°C - 600°C. Previous experiments without the use of a catalytic agent have shown success between 500°C and 600°C [3]. For this study, chromatography paper strips were soaked in CuSO$_4$ then pyrolyzed at different temperatures. Those heated between 450°C and 600°C exhibited the most observable indicators of copper.

Biophysical and Biochemical Characterization of Axonemal Dynein Motor Proteins Purified from Chlamydomonas Flagella

Zach Hubbarth, Rachel Andorfer, Joshua Alper
Department of Physics and Astronomy, Clemson University

Motile biological microstructures engineered from cytoskeletal elements have been used in many applications, such as drug delivery and biomedicine. There is a great, unexplored opportunity to further expand the capabilities of such structures because axonemal dynein motor proteins, which drive the beat of eukaryotic cilia and flagella, have not been used. We are biophysically and biochemically characterizing axonemal dynein motor proteins purified from the flagella of Chlamydomonas (a single-celled species of algae commonly used as a model organism to study flagellar motility) using western blotting, gel electrophoresis, dynein motility assays, and ATPase assays. Our preliminary western blots yielded very little results. This suggests that the purified dynein may not have the expected subdomains (they lack a biotin binding domain that we can use to biophysically characterize the dynein). We will need to continue to test to investigate whether we have dynein. Ultimately, our research into how these proteins work will be applicable to the engineering of motile biological microstructures created from cytoskeletal elements.
Comparing the Programs VASP and CP2K with Computational Catalyst Reactions

Mackenzie Grumbles, Noah Klimkowski, Steven Pellizzeri and Dr. Rachel Getman
Department of Chemical Engineering, Clemson University

A significant fraction of researchers in catalysis are computationalists who use quantum chemistry software to calculate thermodynamic and kinetic values of catalytic reactions. The program behind the curtain making such complex computations needs to be the most efficient available. Researchers want the best program while also being user friendly. VASP is a commercial program currently used by Dr. Getman’s group to calculate the energies, magnetic moments, or geometry optimizations in chemical engineering. CP2K is an analogous open-source program that is gaining popularity. In this work, we compare VASP versus CP2K for calculating various properties of interest to the Getman Group. Specifically, we consider ease of learning, ease of use, accuracy, and efficiency of the two codes. CP2K uses a tree file system in order to find the keywords and tags for each necessary specification in the reaction. CP2K is being proven as the more efficient and preferred chemical engineering computational program. The comparison between VASP and CP2K relies on the ability for each to produce the geometry optimization in the least amount of time with the fewest number of cores. Although CP2K may take slightly more time, observations reveal CP2K’s superiority to VASP in ease of use and organization.

#Values: Communication Analysis of Enacted Institutional Values via Social & Traditional Media

Anna Hardymon, Dr. Andrew Pyle
Department of Communication, Clemson University

Colleges and universities face a wide variety of crises, from natural hazards such as fire and flooding, to manmade events such as shootings and sexual assault. Institutions of higher education seeking to not only survive, but to thrive after a crisis must consider which channels are most effective for a post-crisis communicative response. As a follow-up to prior research on the nature and role of values in the communicative decisions of institutions of higher education, the authors conducted a study of recent crisis events in a sample of 300 colleges and universities. The authors collected two categories of data: official responses from institutions via traditional outlets (e.g., releases posted to institutional web pages or releases submitted directly to news outlets), and official responses posted on university social media pages (i.e., Facebook or Twitter). The findings of the study were both surprising and challenging, pointing to a need for further research in this area and for targeted application of effective communication practices.
Evaluation of Anther Lipidome of Six Peanut Cultivars Under Drought and Heat Stress

Audrey Jen, Dr. Sruthi Narayanan, Zolian S. Zoong Lwe
Department of Plant & Environmental Sciences, Clemson University

Peanut is a major world crop with many economic and nutritional benefits, with the U.S. among the top three peanut producing countries. The majority of U.S. peanuts are grown in the peanut belt, i.e., the southeast. However, climate models predict a global air temperature increase of about 1.4-3.1°C by the end of the 21st century. This coincides with increases in frequency and intensity of drought episodes, which combined threatens food production worldwide. Peanut is most sensitive to drought and heat stress during its flowering stage. A decrease in pollen performance results in lower yield. It is crucial that plant scientists develop high-yielding and drought/heat-tolerant genotypes in order to sustain/increase crop yield and aid global food security. The aim of this field study is to evaluate the anther lipidome of six peanut cultivars, with varying degrees of drought and heat tolerance, to identify specific lipid traits that are associated with better pollen performance under drought and heat stress. We will also measure physiological, agronomic, and biochemical traits. The lipid traits we identify can then be used as biomarkers by peanut breeders to accelerate the breeding process for high-yielding and drought/heat-tolerant genotypes for the U.S. peanut belt.

Low Resistance Actuated Valve for Cardiovascular Experiments

Ray Kean, Talia Makarov, Masoud Farahmand, Professor Ethan Kung
Department of Mechanical Engineering, Clemson University

A heart valve works by allowing blood to flow in one direction but restricting flow in the other. When the pressure upstream is greater than the pressure downstream, the valve opens. Blood regurgitation causes the heart to work harder leading to health problems such as blood clotting and heart palpitations. Commercially available mechanical valves have resistances that are too high for realistically mimicking heart valves. The goal of this project was to design and construct a low-cost valve which would respond to the drops in pressure in order to maintain unidirectional flow by preventing backflow. The valve needs to respond quickly and there needs to be little resistance across the valve when it is open. Using a push-pull solenoid, a motor, a reservoir, and a T-junction valve, we created a flow loop in which we used the solenoid to block flow to mimic the closing of the aortic valve. Observation of data shows a push-pull solenoid and a T-junction can effectively act as a valve to prevent backflow in a flow loop.
Optimization of Magnetic Nanoparticles for Biomedical Use

Corrina Laird, Carol Stegura, Alyssa Livingood, Nardine Ghobrial, Delphine Dean, Thompson Mefford
Department of Materials Science and Engineering, Clemson University
Department of Bioengineering, Clemson University

Alzheimer’s disease and diabetes are the 6th and 7th leading causes of death in the United States, respectively, but neither disease has an effective method for diagnosis. Increased levels of advanced glycation end-products (AGE) are found in conjunction with these conditions. When particles coated with receptors for advanced glycation end-products (RAGE) are exposed to AGE, they will bind with the AGE and increase the hydrodynamic volume of the particles. This increase in volume can be measured using AC magnetic susceptibility as increased hydrodynamic volume shifts the particles’ susceptibility to a lower frequency, due to the following relationships:

\[ \tau_{\nu} = \frac{4\pi \eta \nu}{K_{B}T}, \quad \frac{1}{\tau_{\nu}} = \omega \]

Cobalt ferrite nanoparticles were synthesized using an extended LaMer drip synthesis and were subsequently characterized using Transmission Electron Microscopy (TEM), Dynamic Light Scattering (DLS), and AC magnetic susceptibility. The results were compared to theoretical calculations and demonstrated differences as the solvents were varied. Therefore, in future work with AC magnetic susceptibility, viscosity specifically must be accounted for, especially as the method is adapted for biological fluids in the RAGE project.

Pulse-Coupled Oscillator Control Algorithms in Robot Networks

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Synchronization and desynchronization in networks is a highly studied topic in many electrical systems, but there is a distinct lack of research on this topic with respect to robotics. Creating an effective decentralized synchronization algorithm for a robotic network would allow multiple robots to work together to achieve a task and would be able to adapt to the addition or loss of robots in real-time. The purpose of this study is to analyze the efficacy of different synchronization algorithms already developed by researchers on a real-world robotic platform. Successful programs were developed using Python 3 to run six different algorithms on a novel robot “swarm”. Using Raspberry Pi microcomputers to control repurposed Roombas known as iRobots created this real-world demonstration of proven mathematical concepts. Observation of data showed how adjusting parameters of the algorithms affected both the time to reach a desired state of synchronization or desynchronization and how the network maintained this state. Of the six successful algorithms tested, Phase Response Curve or PRC Sync worked most effectively for synchronization, while its counterpart PRC Desync had the best results for desynchronization. Future work in cooperative robotics will likely see success using these algorithms to accomplish a variety of tasks.
Synthesis of a Novel Perylene Imide Chromophore for Dye Sensitized Solar Cells

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Current silicon based solar technology is not competitive in the market due to its high cost of production. A dye sensitized solar cell (DSSC) is a different solar technology characterized by its low cost. DSSCs operate by the photoexcitation of a dye molecule which transfers an electron to a semiconductor, generating current. As of 2014, DSSCs have a record efficiency of 13%. Perylenes are a group of dyes of potential interest for DSSC technology. In attempts to synthesize and purify a novel Perylene, techniques such as reflux, TLC, flash column chromatography, rotovap, and MALDI-TOF are used.

The Effects of Conscious Leadership in Personal and Professional Settings

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Conscious leadership, a set of principles and practices that encourage self-awareness and emotional intelligence, has been implemented by Greenville Health System (GHS) as its leadership development program. Because the content of this program emphasizes interpersonal effectiveness, which is a necessary skill in one’s personal life, we hypothesized that leaders who participate in Conscious Leadership would express benefits of the program beyond the workplace. To examine how leadership training can positively influence or benefit one’s personal and professional life, a survey was administered to 966 GHS leaders. Open-ended items were coded and qualitatively analyzed to identify emergent work-life enrichment themes. 313 leaders stated that Conscious Leadership facilitated improvements in areas such as self-awareness, situational-awareness, and understanding of others. These results will be used to improve leadership development efforts at GHS. Leadership development in healthcare can have a positive impact on leaders’ personal lives in addition to their professional lives, suggesting that Conscious Leadership in particular may help healthcare leaders to be more resilient and effective in their work and at home.
Synthesizing Tetra-2-pyridinylpyrazine (tppz) tri-iodide salts via Halogen bonding

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The compound tppz (2,3,5,6-tetra(2'-pyridyl)pyrazine) is a ligand that is used in the construction of methanol-based fuel cells and structural studies show its ability to mediate intermetallic coupling. It is a very versatile electron donor that has a multitude of binding formations. The tppz pyridyl rings are twisted from collinearity due to steric effects caused by the repulsive forces between overlapping electron clouds. There are solvent-dependent differences in the internal energies of conformers that influence the structure of the polymorph process that is crystallized from the solvent and the reaction between tppz and the other reactant. This study examines the differences in tppz tri-iodide salts that are synthesized via halogen bonding. These reactions were conducted under 1:1, 1:2, and 1:3 ratios and with a variety of solvents. These salts were examined using x-ray crystallography. Many of the samples were determined to only contain recrystallized reactants. The 1:3 ratio compound TPPZ + I₂ with the solvents DCM and Acetone had the only conclusive reaction product crystallization.

DominANT Invasive Species Disrupt Food Webs

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Fire ants are invading the Southeastern US and dominating food webs. They are capable of altering many species interactions at multiple trophic levels due to their omnivorous and aggressive feeding behavior. We used a seed-based food web to evaluate potential antagonistic interactions between the fire ants and native community of seed feeders (insects and small mammals) and then determined their impact on pigweed seed removal across a variety of habitats. We measured ant activity, other invertebrate granivore activity, seed removal, and vegetative refuge. Ant activity and seed removal increased in plots with higher amounts of refuge. Unexpectedly, the activity of the rest of seed-feeding invertebrate community was reduced in weedier plots. We saw indirect evidence of antagonistic interactions between fire ants and other invertebrate granivores and also between small mammals and other invertebrate granivores, both mediated by the refuge. Overall, we found that refuge is the strongest predictor of top-down suppression, despite the complexity of the interactions between the other groups of seed-feeders.
Synthesis of Magnetic Nanorods for Biological Application

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A challenge in microbiology is understanding the physical properties of biofluids, such as viscosity and elasticity. Since these properties change at nanometer scales, it is necessary to develop nanosized probes. These probes can be synthesized by a method called template-assisted electrochemical deposition. Through this process, we deposited Nickel ions into a porous ceramic membrane to create the nanorods. We ran the electrodeposition for varying time in order to study the dependence of the length of nanorods on electrodeposition time. Intuitively, the longer run times would result in longer rods. In order to analyze the data quantitatively, we measured the actual length of the rods from images and compared them to theoretical values. The experimental results match the theoretical prediction perfectly except of the nanorods obtained at the longer deposition time. The longer rods were bent and broken during sonication, hence there were no possibility to evaluate the original synthesized nanorods.

Effects of Wood Flour and Perlite on Magnesium Oxychloride Cement Boards

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Magnesium oxychloride (MOC) cement panels are a sustainable, fire-resistant material suitable for structural application without further reinforcement. MOC boards can be used as a building material on its own without steel supports if it is reinforced with perlite and wood flour. In this study, perlite and wood flour were added in different percentages of the overall board weight to determine their optimum amounts for improving structural properties. These weights ranged from 0% to 10% and increased by increments of 2.5% for each ingredient. Once the ingredients were mixed, the cement was poured into a mold and allowed to cure at 45°C for 23 hours. The board was then cut into seven smaller strips that were tested on a three-point bending apparatus to determine their flexural strengths. The results for individual strips from a single board were averaged to find that board’s strength. Results showed no correlation between the amount of perlite present and strength, but when the weight percent of wood flour was increased, board strength increased slightly. Repeated testing is needed to increase arrive at more definitive conclusions and future work may include testing a wider range of perlite and wood flour percentages.
Analysis of Magnesium Oxychloride Water Stability

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Magnesium Oxychloride (MOC) cement has potential to be used for structural insulated panel systems due to its fire retardancy, low carbon footprint, and low toxicity. However, its water instability makes it unsuitable for widespread construction. Research about MOC based cements has been conducted since the early 1900’s, yet few stabilizing methods have shown promising results. Additionally, important information about the crystalline/amorphous composition has not been explored. This project aims to further understand the kinetics of the degradation of MOC in the presence of water while gaining a deeper understanding of the reactions that occur at a molecular level. Experiments were conducted using a control MOC board with 5% Wood Flour and 5% Perlite mixture and then with 2.125% $\text{H}_3\text{PO}_4$ (Phosphoric Acid). MOC boards were placed in 75C water for 2-10 hours and taken out in 2 hour increments. Using the 3 point test and X-Ray Diffraction (XRD), we were able to quantify the relationship between the strength of the boards and their compositions. With a deeper understanding of the crystalline/amorphous phase in addition to the cement’s structural and water stability, MOC based cements can provide a well performing and green alternative to common fire-resistant building materials.

Catalytic Chemistry on the Molecular Level – Single Atom Catalysts in the Depolymerization of Lignin

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Lignin has the potential to be used as a renewable feedstock for chemicals, fuels, and energy without the threat on food production. It is the most abundant source of aromatic carbon in nature. Approximately 1/3 of carbon in lignocellulosic biomass is wasted when it is burned for process heating. The aromatic carbon found in lignin has the potential to be used for valuable chemicals, however, conventional catalysts are unable to depolymerize the structure. Single-atom catalysts (SAC) can be tuned to promote selectivity in breaking the C-C and C-O bonds of the lignin structure without degrading the molecule completely. SACs ensure maximum monomer production and energy optimization in the depolymerization of lignin. The aim of this project is to uncover how SACs function to extract monomers from lignin. Specifically, we are interested in how a vanadium-oxide SAC decomposes a lignin dimer model compound into aromatic monomers and small oligomers. To understand this process, we used the graphical user interface (GUI) GaussView to construct the various chemical species that are involved and calculating their energetics on the Palmetto Cluster. Doing this provides insights about the thermodynamics and kinetics of lignin depolymerization, which are key properties needed to understand the catalysis.
Biochromatic Sensors for Food Safety

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Polydiacetylenes (PDAs) are polymers that change colors in the presence of a stimuli, like a solvent or other chemical, or environmental change, such as an increase in temperature. This property makes them potential candidates for development of smart packaging for food, responsive wound dressings, bacterial or chemical sensors. One type of polydiacetylene is 10,12-pentacosadiynoic acid (PCDA). The purpose of this project is to grow crystals of PCDA and PCDA metal salts to learn how PCDA works, and to use that information to help develop smart materials for application as sensors in the food industry and diagnostic devices in the medical field. Solutions of PCDA and various metal hydroxides were prepared, heated under pressure, and cooled to grow crystals. Crystals were then analyzed using techniques such as X-ray powder diffraction.

Repurposing Vintage Cell Phones for use in Proximity Sensors

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An estimated 150 million mobile phones are discarded in the US alone each year, each of which contains materials that can be harmful to the environment. This makes it very difficult and sometimes expensive to deal with the end of a cell-phone’s life. For those reasons, we integrated a vintage cell phone into one of our lab’s current projects: creating an interactive book. We developed a proximity sensor based around the phone’s camera in conjunction with fiber optic cables. This created another method to repurpose cell phones, rather than discarding them. We used fiber optic cables to transfer light, bouncing from a page, from the sensor to the camera of a Samsung Galaxy S5. We analyzed the image using Python and OpenCV to develop sensors to tell which sensors were lit (covered) and which were unlit (uncovered). This enabled us to create reliable proximity sensors, which we used to tell what page the reader was looking at. We plan to expand upon this project in the future to create a more visually refined and robust product out of this initial prototype.
Self-Reported vs Qualitatively Coded Responses to Conscious Leadership Among Greenville Health System Leaders

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Conscious Leadership, a leadership development program incorporating self-awareness, emotional intelligence, and critical social thinking, has been implemented with leaders across Greenville Health System (GHS). To assess the reactions to and effectiveness of this training, a questionnaire was administered to leaders to gauge their knowledge of Conscious Leadership principles as well as their self-reported reactions to the program. The purpose of this study was to use the affective circumplex model (Russell, 1980) to compare the self-reported, qualitative reaction items to qualitative open-ended items in the survey. In other words, when asked about their feelings toward Conscious Leadership, do leaders rate themselves according to how they truly feel? We found that 56% of leaders rate Conscious Leadership more favorably than what their qualitative responses indicate. Further, the correlation between reactions to Conscious Leadership and their declarative knowledge score is stronger when using the coded responses compared to the self-report. In sum, while GHS leaders do demonstrate positive reactions to Conscious Leadership, it is important to understand that there are factors that may lead to inflated or inaccurate responding.

Investigation of Recent AluS Insertion Candidates

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AluS is a subfamily of Alu that is thought to no longer be active in humans. A previous paper proposed several AluS elements as recent insertions. This study investigates the likelihood of these elements being true recent insertions. To do this, each locus was compared across multiple species to estimate when the insertion occurred using comparative genomics approaches. Each Alu element was also analyzed with RepeatMasker to confirm their AluS identity. As a result, there were three elements that were present in distant primate relatives of humans, three that were only present in humans, and one that was present in none of the reference genomes searched. Additionally, one element was classified as an AluY by RepeatMasker. In conclusion, two elements appear to be likely candidates for recent insertions, one could be depending on its classification as either an AluS or AluY, another element is potentially linked to a deletion event, and three elements are unlikely to be young insertions.
ER Stress and Unfolded Protein Response in Y. Lipolytica Cells

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Yarrowia lipolytica, a species of yeast, has been engineered to increase Omega 3 production levels. As a result of rigorous genetic engineering, the endoplasmic reticulum (ER) is expected to become overloaded. In this project, we are studying the stress-induced pathway that occurs with overloading in the ER in yeast. To deal with overloading, yeast employ an unfolded protein response (UPR). When a protein becomes unfolded, its hydrophobic core is exposed creating a nonfunctional protein. From there, Kar2 protein binds to the unfolded protein, initiating UPR. As the response continues, the cell increases expression of Kar2, in addition to increased levels of IRE1, HAC1 unspliced, and HAC1 spliced. By extracting RNA from three Omega 3-producing strains and two control strains, we could discover the levels of expression of each of those proteins involved in the stress-induced pathway in correspondence with Omega 3 production. The goal was to see which UPR indicators were upregulated/downregulated via quantitative polymerase chain reaction (qPCR) analysis of RNA samples from all five strains; however, collected data presented mixed results. We determined DNA contamination of RNA samples to be a contributing factor as well as poor primer design, indicated by subpar primer efficiencies. Due to the specificity of qPCR, future analysis will require improved primer design and improved purity of RNA samples.

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From the left: Emily Miller, Anna Hardymon, and Martyn Lemon.

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