#1 - WHEN TERRITORIAL SALAMANDERS CHEAT: A TEST OF THE DEAR ENEMY PHENOMENON IN SOUTHERN RED-BACKED SALAMANDERS. Kenzie Medley, Biology. Faculty Advisor: Dr. Alicia Mathis

The "dear enemy" hypothesis states that a territory owner shows reduced aggression toward a neighbor once territorial boundaries are established. Neighbors that do not restrict their activity to the agreed upon territory boundaries can be characterized as "cheaters" and might be subject to retaliation. To establish territory boundaries, we exposed each focal Southern Red-backed Salamander, *Plethodon serratus,* to reflections produced from a mirror located on one side of an arena for a week. To simulate a cheating neighbor, we moved the mirror to the other side of the arena; a cooperating neighbor was simulated by replacing the mirror in its original location. Salamanders exposed to the cheating "neighbor" were significantly more aggressive than salamanders exposed to the cooperating "neighbor". Discrimination against "cheating" neighbors is consistent with the dear enemy hypothesis.

#2 – RESPONSE TO CONSPECIFIC ALARM CUES BY *AMBYSTOMA* SLAMANDER LARVAE. Katy Gardner, and Ben Dalton, Biology. Faculty Advisor: Dr. Alicia Mathis. Detection of predators early in a predation sequence may allow prey increased probability of survival by taking evasive action. For aquatic species in ephemeral ponds, visibility is often limited, so assessment of predation risk via chemical cues can be useful. Prey may directly detect cues given off by a predator or detect their presence indirectly via alarm cues released when a nearby conspecific is attacked. Certain *Ambystoma* salamanders found in Missouri breed in vernal ponds, and larvae suffer high rates of mortality due in part to high levels of predation. We tested whether larvae can assess predation risk by detecting chemical (alarm) cues released from the skin of damaged conspecifics or heterospecific prey (tadpoles). As a control, we also examined responses to damaged skin from a terrestrial salamander from a different taxonomic family (*Plethodon angusticlavius*). Since decreased activity is an antipredator response for larval *Ambystoma,* we recorded number of moves before and after presentation of the stimuli. Larvae showed stronger reductions in activity to conspecific skin extracts, but not to any other stimuli. Our results indicate that these larval salamanders may possess a conspecific alarm cue, but they do not appear to respond to alarm cues from a syntopic species.

#3 – EFFECTS OF REINTRODUCTION OF PRESCRIBED FIRE ON OVERSTORY PRODUCTION IN MISSOURI OAK-HICKORY WOODLANDS. Miranda Keller, Biology. Faculty Advisor: Dr. Alexander Wait.

Prescribed fire is commonly used to manage degraded oak/hickory woodlands. Degraded woodlands are characterized by high overstory cover. Overstory production is correlated with leaf litter. I examined how reintroduction of prescribed burning in an Ozark oak-hickory degraded woodland affects total over story production and production of oaks and hickories. The study site is located within the Drury/Mincy Conservation Area in Taney County, Missouri where there are unburned sites (control); sites burned every 2-4 years since 1999 (recently burned); and sites burned every 2-4 years since 1980 (continuously burned). Litter was collected in 0.315 m^2 baskets 0.5 m above ground annually in November and December from 2000-2016. After collection, leaf litter was separated into four categories: oak, hickory, other species, and acorns. I found that in control sites, total annual leaf litter varied between ~240 – 400 g/m^2, recently burned sites varied between ~200 – 350 g/m^2 and continuously burned sites varied between ~100 – 200 g/m^2. I found that total leaf production in recently burned woodland sites was not significantly lower than in control woodland sites and still significantly higher than in continuously burned sites. I also found significant changes in species-specific production as a function of fire history and time.

#4 – PROJECTED DISTRIBUTION OF TEXAS MOUSE (PEROMYSCUS ATTWATERI) UNDER PAST AND FUTURE CLIMATE CONDITIONS. Victoria Starnes, Biology. Faculty Advisor: Dr. Sean P. Maher

Global change has led to the expansion and contraction of species ranges, in part due to alterations to habitats and to direct responses to changes in precipitation and temperature. The Texas mouse (*Peromyscus attwateri*) is a glade species in southern Missouri with a modern range extending southwest into Texas. Despite its distinction as a glade species in Missouri, *P. attwateri* can be found throughout a wide range of other rocky habitats including shrubby woodlands, cliffs, and ravines in other parts of its range. We modeled climate associations of *P. attwateri* to better understand how range shifts in the past may have occurred and estimate how their range may shift in the future. Using georeferenced museum specimens and models of current climate, we created ecological niche models for *P. attwateri* using MaxEnt. Then we projected the models onto past and future climate scenarios to estimate potential changes in the distribution of *P. attwateri*. Given that rocky and grassland habitats are becoming less common in an era characterized by additional anthropogenic forces including fire suppression, projected ranges likely will be over-estimates of the realized distribution of *P. attwateri*.

#5 - *LEMNA MINOR* TOLERANT OF POLLUTANTS IN OIL REFINERY EFFLUENT? Jordan Heiman, Lauren Griffin, and Madison Gurski, Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles.

Waste effluent from oil refineries contain many compounds, such as sulfates, lead, and radioactive materials. The ultimate destination of this waste effluent is aquatic ecosystems. Previous research has examined the efficiency of wetlands to treat waste effluent but few of these studies have focused on the effects of the effluent on the aquatic organisms in these systems. A major component of effluent from oil refineries is sodium sulfate (typically at around 1683 mg L^{-1}), which is among the most abundant ions in seawater. We grew *Lemna minor* in nutrient solution with different sodium sulfate concentrations (0, 250, 500, 1000, 2000 mg L^{-1}) to determine the effects on biomass and chlorophyll production. Total biomass was estimated using area cover. Chlorophyll concentrations were determined using an ethanol extract and spectrophotometric methods. Preliminary results indicate that biomass and chlorophyll concentrations were similar for all sodium sulfate treatments. These results indicate that high sodium sulfate concentrations had no effect on growth or chlorophyll production. Further research is needed to determine if *L. minor* is tolerant of high sodium sulfate concentrations and if the plants accumulate sodium sulfate when exposed to high concentrations.

#6 – *LEMNA MINOR* GROWTH: EFFECTS OF SILVER NANOPARTICLES AND CARBON. Madison Gurski, Lauren Griffin, and Jordan Heiman, Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles.

Lemna minor is a fast-growing, floating aquatic plant known to accumulate metals, including zinc, lead, and cadmium. These characteristics make it ideal for toxicity and uptake studies. Recent research has shown that silver nanoparticles (AgNPs) affect growth of *L. minor* at 160 µg L^{-1}. AgNPs are used in detergents, food packaging, and textiles and can enter wastewater after use. Most wastewater treatment processes may not remove these nanoparticles, resulting in their release into aquatic ecosystems. Our study investigated the effects of nanoparticles with additions of leaf litter on *L. minor* biomass and chlorophyll production. Leaf litter was included in this study as a carbon source to determine if additions of carbon might minimize the effects of nanoparticle exposure. We grew *L. minor* in nutrient solution with nanoparticles (0 and 183 µg L^{-1} AgNPs) and with leaf litter (0 and 2% carbon) for seven days. We measured total biomass and chlorophyll content to determine effects on plant growth. Preliminary results indicated that exposure to AgNPs did not have an effect on *Lemna minor*'s chlorophyll content and biomass. However, plants grown with AgNPs and leaf litter appeared to have lower biomass than plants grown with leaf litter additions.

#7 – DYNAMIC DYNAMIN INTERACTS WITH THE TETHER GARP. Jared Smothers, Uma Saimani, Biology. Faculty Advisor: Dr. Kyoungtae Kim.

Retrograde traffic from the endosome toward the *trans*-Golgi Network (TGN) requires the sorting of cargo at the endosome, and the generation of cargo-laden transport carriers. Transport carriers are trafficked via the cytoskeletal tracks for subsequent tethering and fusion at the TGN. Vacuolar Protein Sorting 1 (Vps1) is a yeast dynamin-like protein, which has been implicated in the retrograde recycling pathway. In yeast, the GARP tethering complex is responsible for anchoring vesicles at the late Golgi membrane. Previous research found genetic interaction between Vps1 and all components of the GARP tethering complex; leading us to hypothesize that Vps1 functions together with the GARP complex for endosome-to-TGN trafficking. Using a yeast-2-hybrid system we identified a 33-amino acid region near the C-terminal of Vps51 (a subunit of the GARP complex) that interacts with Vps1. Vps51 mutants harboring point mutations at conserved residues in this region did not interact with Vps1, and displayed severe defects in endosome-to-TGN transport. Functional analysis revealed Vps1 acts upstream of Vps51, and Vps1 is required for proper targeting of Vps51 to the late Golgi. These finding suggest that Vps1 may play an essential role in the organization of a local protein network required for the later stage of the endosome to Golgi traffic.

#8 – DIFFERENTIAL GENE EXPRESSION PROFILE OF SACCHARAOMYCES CERVISIAE EXPOSED TO Ag AND CdSe/ZnS NANOPARTICLES. Chelsea Campbell, Biology. Faculty Advisor: Dr. Kyoungtae Kim.

Nanoparticles are commercially used in everyday products including zinc sunscreen and water resistant fabrics and surfaces, but in the future they may be used in targeted treatment of cancer, printable monitoring systems, and foldable phones. Understanding the effects of nanoparticles is crucial for the responsible use of these technologies. The aim of this project is to investigate the effects of nanomaterials on budding yeast (*Saccharomyces cerevisiae*) using growth assays, FUN-1 staining for metabolic activity and RNA sequencing. Almost every gene in the yeast genome has a human homolog, making yeast a great model for understanding the potential effects of nanoparticles on human health. In this study we specifically look at silver (Ag) and Cadmium (CdSe/ZnS) nanoparticles. When exposed to silver, growth curves suggest an inhibitory effect of the treatment in concentrations above 5µg/ml. In addition, FUN-1 staining results indicate little metabolic effect from the same concentrations of silver exposure. Hundreds of the same genes in both Ag and CdSe/ZnS treated cells were differentially expressed, the majority of which are responsible for ribosomal biogenesis and nucleotide binding. The resulting expression profile leads us to suspect that Ag and CdSe/ZnS nanoparticle exposure creates a stress environment in the cell, a suspicion which we are further investigating experimentally.

#9 – ENGINEERING A CRISPR-BASED SCREENING SYSTEM IN *ESCHERICHIA COLI*. Micheal Pilkenton. Biology. Faculty Advisor: Dr. Laszlo Kovacs.

CRISPR is a bacterial immune system to protect the cell from viruses. It accomplishes this by incorporating a short DNA sequence unique to the invading pathogen into the genome of the bacterial cell. This sequence is transcribed into an RNA sequence, known as crRNA, which targets the DNA of the phage. This targeting is carried out by the crRNA associated with the enzyme Cas9, which cuts DNA. Perfect complementarity between the crRNA and the so called seed sequence is required for Cas9 to cut the target DNA. In my project, I am attempting to develop a CRISPR-based screening method to detect mutations in the bacterial genome. I designed a crRNA to target a specific seed sequence in the *E. coli* genome. The detection of mutations is based on the ability of Cas9-crRNA complex to cut the bacterial chromosome, which in turn kills the cell. If a mutation in the seed sequence changes the bacterial genome, then Cas9 will not cut the genome and bacterial cell stays alive. Based on this principle, naturally occurring mutations can be detected using the CRISPR system with high efficiency.

#10 – THE IMPACT OF ENGINEERED NANOSTRUCTURES ON GENE EXPRESSION IN PLANTS. Natalie Venette, Cory Hanson, Collin Portz, Biology. Faculty Advisor: Dr. Laszlo Kovacs.

Engineered nanoparticles are produced in rapidly increasing quantities and used in many new technologies around the world. However, little is known about the environmental toxicity of these products. This study seeks to understand the toxicity of silver quantum dots (AgQDs) and carbon nanotubes (CNTs) on plants by measuring differential gene expression in plants exposed to them. The model plant, *Arabidopsis thaliana*, was grown in a synthetic medium supplemented with AgQDs, CNTs, or in medium free of nanostructures (control). Each of these treatments was performed in three biological replicates. Following 13 days of growth, total RNA was extracted, mRNA was purified, and sequencing libraries was constructed and sequenced on an Illumina Hi-Seq. RNA-seq data was analyzed using a bioinformatics pipeline (composed primarily of software TopHat, Cufflinks, and Cuffdiff) on the Windows-based software suite CLC Genomics Workbench to align the RNA-seq reads to the *Arabidopsis thaliana* reference genome sequence, assemble transcripts, and analyze transcript levels and perform statistical tests to identify gene expression changes across the three different treatments. One gene was differential expressed when exposed CNTs while twenty-six differentially expressed genes where found when exposed to AgQDs. qPCR was performed on five to eight genes to validate results.

#11 - ELUCIDATION OF DIRECT REGULATORY MECHANISMS OF THE NLRP3 INFLAMMASONE THROUGH GENERATION OF A YEAST-2-HYBRID. Thomas Freeman and Abbi J. Mabary. Biology. Faculty Advisor: Christopher Lupfer.

NOD-like receptors (NLRs) are a class of cytoplasmic proteins essential for the initiation and regulation of immune responses to infectious disease, metabolic and cellular damage and cancer. The human genome encodes for 22 NLR proteins. However, only about half of the 22 NLRs have known functions, and the mechanisms by which they function are even more ambiguous. Previous research indicates that some NLRs, like NLRP3, can activate Caspase-1 and form the "Inflammasome", which is a multiprotein complex responsible for cleaving the potent inflammatory cytokine interleukine-1β (IL-1β). We are therefore embarking on a journey to find novel proteins that interact with NLR proteins to decipher the mechanisms by which they function. We are generating a yeast 2-hybrid system to examine the interaction of NLR proteins with a human cDNA library. Novel interactions discovered through this 2-hybrid screen should provide insight into the function of these NLR proteins and help us understand the immune response to infectious and non-infectious diseases.

#12 - GENERATION OF YEAST 2-HYBRID CLONES TO EXAMINE THE ROLE OF NUCLEOTIDE OLIGOMERIZATION AND BINDING DOMAIN (NOD)-LIKE RECEPTORS. Abbigale Mabary, Thomas Freeman, Angeline Rodriguez and Hazar Abysalamah. Biology. Faculty Advisor: Dr. Christopher Lupfer.

NOD-like receptors (NLRs) are a class of cytoplasmic proteins essential for the initiation and regulation of immune responses to infectious disease, metabolic and cellular damage and cancer. The human genome encodes for 22 NLR proteins. However, only about half of the 22 NLRs have known functions, and the mechanisms by which they function are even more ambiguous. Previous research indicates that some NLRs activate inflammation, while others, like NLRP12, functions as regulators of inflammation, thus serving as a negative feedback mechanism. NLRP12 suppresses inflammation by inhibiting the transcription factor NF"κB", which activates transcription for cytokines that activate the immune response cascade. Inhibition of NFκB by NLRP12 is important in the prevention of a hyper-inflammation, which is involved in severe infections as well as cancer development. Although the general function of NLRP12 is known, how it is activated is not known. We are, therefore, embarking on a journey to find novel proteins that interact with NLRP12 in an effort to decipher the mechanisms by which they function. We are generating a yeast 2-hybrid system to examine the interaction of NLRP12 with a human cDNA library. Novel interactions discovered through this 2-hybrid screen should provide insight into the function of this NLR protein and help us understand the immune response to infectious and non-infectious diseases.

#13 - INVOLVEMENT OF CGRP AND PKA IN THE INITIATION OF TRIGEMINAL PAIN SIGNALING IN A MODEL OF TMD. Harlee Kelley, Jordan Hawkins, Biology. Faculty Advisor: Dr. Paul Durham

Temporomandibular joint disorder (TMD) is a chronic pain condition caused by trauma or by prolonged jaw opening during a routine visits to a general dentist or orthodontist. TMD is characterized by peripheral and central sensitization of trigeminal nociceptive neurons, which is mediated by calcitonin gene related peptide (CGRP) and protein kinase A (PKA). Despite the prevalence and morbidity associated with TMD, there are currently no approved FDA drugs specific for TMD. Thus the goal of my study was to investigate the potential of using selective CGRP or PKA antagonists as therapeutic options in a clinically relevant model of TMD. Male Sprague-Dawley rats were pre-injected with CGRP or PKA antagonists and subjected to near maximum jaw opening for 20 minutes. A low level of staining was observed in tissues obtained from control animals including naïve, isoflurane, and intrathecal saline. The levels of CGRP and PKA were greatly elevated after prolonged jaw opening. Pretreatment with the CGRP antagonist or a PKA inhibitor was sufficient to repress levels of CGRP and PKA. Our findings provide evidence that CGRP and PKA levels correlate with TMD pathology and thus, inhibiting their signaling may be beneficial in the treatment of TMD caused by jaw joint injury.

#14 - EARLY LIFE STRESS CAUSES GUT DYSBIOSIS: EVIDENCE FROM NEXT GEN SEQUENCING. Orion Peterson, Pendilton Whaley, Shelby Harris, Jordan Hawkins, and Lauren Cornelison. Biology. Faculty Advisor: Dr. Paul Durham

Dysbiosis is an imbalance of the bacterial flora that populate the intestinal tract and is often seen in conjunction with health problems such as inflammatory bowel disease, obesity, and chronic fatigue. Secondary traumatic stress is described as sensitization in a naïve individual elicited through exposure to an individual who directly experienced some trauma. The goal of my study was to examine the effects of secondary traumatic stress on the diversity and composition of gut flora and its implications on nociception. Male Sprague Dawley rats (sender) were subjected to forced swim testing (primary traumatic stress) and were co-housed with pregnant female Sprague Dawley rats (receiver). Bacteria in fecal and cecal samples from the F1 generation (>45 days old) were quantified using next-generation sequencing. Both male and female offspring of mothers co-housed with stressed males had lower bacterial diversity in their fecal and cecal samples when compared to offspring of unstressed animals. More specifically, there was a reduction in the amount of Lactobacillus and Bacteroides in the stressed offspring. Results from my study provide the first evidence to our knowledge that secondary traumatic stress can induce pathophysiological changes in the gut that correlate with enhanced nociception and sensitization of trigeminal neurons.

#15 - TEMPOROMANDIBULAR JOINT PATHOLOGY INVOLVES INCREASED EXPRESSION OF ACTIVE ERK AND PKA IN TRIGEMINAL GANGLION NEURONS IN FEMALE RATS. Jessica Cox, and Neelima Chelliboina. Biology. Faculty Advisor: Dr. Paul Durham.

Temporomandibular joint disorder (TMD) is characterized by pain localized to the temporomandibular joint (TMJ) and muscles associated with mastication. TMD pathology involves activation of primary nociceptive neurons that promote peripheral sensitization and excitation of second order neurons implicated in the development of central sensitization. Prior studies in our lab had provided evidence that prolonged jaw opening in a sensitized animal mediated by neck muscle inflammation resulted in the development of a chronic pain state. The goal of my study was to investigate the cellular changes associated with sustained pain in the TMJ and masseter muscle in adult female Sprague-Dawley rats. Using immunohistochemistry and fluorescent microscopy, the active form of extracellular regulated kinase (ERK) and protein kinase A (PKA) were found to be upregulated in the neuronal cell bodies in sensitized animals 28 days after being subjected to prolonged jaw opening when compared to levels observed in jaw or muscle alone or naïve, untreated animals. Results from my study provide the first evidence that increased expression of the pro-inflammatory proteins ERK and PKA likely play an important role in the underlying pathology of TMD and maintenance of a chronic pain state of trigeminal nerves.

#16 - MECHANISM ELUCIDATION OF GOLD-CATALYZED THREE-COMPONENT REACTIONS FORMING FURANS. Michael Bakker, Chemistry. Faculty Advisor: Dr. Matthew R. Siebert.

Reports utilizing gold-catalyzed three-component reactions have been on the rise in the past decades. Recently, creation of furan using a gold-catalyzed three-component reaction in a single-pot synthesis has been reported. This technique improves the yield and produces the furan in a more environmentally friendly manner. Among other applications, furans have found use in heart medications as an anti-arrhythmic and anti-hypertensive. Herein, analysis of the gold-catalyzed three-component reaction will be presented. The minimum energy pathway (reaction mechanism) will be elucidated using B3LYP, M06, and B2PLYP. Optimizations and transition state searches were conducted in an attempt to better understand the reaction mechanism.

#17 – TRAFFICKING OF FLUORESCENTLY-LABELED G-WIRE DNA IN HUMAN CERVICAL CANCER CELLS. Brennon Foster, Chemistry. Faculty Advisor: Dr. Katye M. Fichter.

A major challenge in the field of cancer research is the development of a therapeutic that is both effective and selective. Studies in recent decades have discovered that G-wire DNA may overcome this challenge. G-wire DNA is a tube-like, quadruplex structure formed when four parallel guanine-rich oliognucleotides (GROs) base-pair. While the mechanism by which G-wire DNA selectively inhibits the proliferation of cancer cells has been elucidated, the trafficking of G-wire DNA to an intracellular target has not. In this project, we transfected human cervical cancer (HeLa) cells with fluorescently-labeled G-wire DNA. Immunocytochemistry (ICC) was used to label the golgi apparatus, endoplasmic reticulum, nucleus, endosomes, and lysosomes of the transfected cells in an attempt to co-localize the G-wire DNA to these organelles. It was found that G-wire DNA may interact with the chemically attached fluorophores to alter their fluorescence emission spectra. Unfortunately, the altered emission of these fluorophores complicated microscopic analysis of G-wire DNA intracellular trafficking. While the trafficking pattern of G-wire DNA has not been identified, future experiments have been planned to investigate different fluorophores for G-wire DNA trafficking experiments.

#18 – COMPUTING NUCLEAR MAGNETIC RESONANCE (NMR) CHEMICAL SHIFTS FOR THE DEOXYRIBONUCLEIC ACID (DNA) NUCLEOBASE ADENINE. Bryttani West, Chemistry. Faculty Advisor: Dr. Matthew R. Siebert.

Nuclear magnetic resonance spectroscopy (NMR) is an important tool used to infer geometrical data for deoxyribonucleic acid (DNA). Changes in chemical shift due to space interactions of the DNA bases gives important information about the distance between the nucleobases. Herein, we aim to computationally model this through space interaction. Quantum chemical NMR calculations were run on several orientations of an adenine dimer. The distance or angle between the rings was varied and differences in ^{1}H and ^{13}C chemical shifts were computed.

#19 - RECOMBINANT EXPRESSION OF *Pfu* DNA POLYMERASE IN *E. COLI*. Amber Zurliene, Katee Moore, Kendra Larsen. Chemistry. Faculty Advisor: Dr. Keiichi Yoshimatsu.
Recombinant DNA technology has allowed for different proteins of interest to be engineered to exhibit a better function or to mitigate an undesired harmful function. DNA polymerase is one of the routinely used biomolecular tools in the process of manipulating the genes of interest. In this work, a plasmid, pET16b.pfu, was purified, digested, and analyzed by gel electrophoresis. Through the use of this plasmid, DNA polymerase from *Pyrococcus furiosus* was expressed in *E. coli*. This DNA polymerase will be utilized for PCR (polymerase chain reaction) and protein engineering applications in our future work.

#20 - INVESTIGATION INTO CYTOTOXITY OF HELA AND WIDR CANCER CELLS USING FOUR PLATINUM AND PALLADIUM CYANOXIMATE COMPLEXES
Stephanie Dannen. Lauren Cornelison. Chemistry. Faculty Advisors: Dr. Nikolay Gerasimchuk and Dr. Paul Durham.
Cisplatin and other platinum-based anti-cancer drugs are among the most often prescribed chemotherapeutic agents. However, side effects of such compounds can be severe and dose-limiting, and some types of cancer can develop resistance to current platinum based therapies. Limited solubility of these drugs in human tissues is also well known. Although palladium is a less toxic and more cost effective alternative to platinum based therapies, its cytotoxicity in human cells has not been as thoroughly studied. We have synthesized several novel platinum and palladium cyanoximate complexes which are currently being tested in cytotoxicity assays of cultured HeLa (cervical epithelioid carcinoma) and WiDr (colon carcinoma) cells with Cisplatin as a positive control. Cyanoximates are a diverse group of ambidentate organic ligands which easily form organo-metallic complexes and have been shown to have substantial biological activity (growth regulating, antimicrobial, anticancer, etc). Combined with the anti-tumor activity of platinum and palladium, these compounds have shown levels of cytotoxicity comparable to Cisplatin.
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#21 – INVESTIGATING PEPTIDE SELECTIVITY AND AFFINITY TO METAL IONS: DEVELOPING QUALITATIVE ASSAYS OF PEPTIDE-METAL ION INTERACTIONS USING METAL ION DEPENDENT DYES AND CELLULOSE MEMBRANES. Michael Guile, Chibuike Obinwa, Chemistry. Faculty Advisor: Dr. Keiichi Yoshimatsu.
It has been known that several classes of proteins and peptides have binding abilities to form complexes with metal ions. Examples include common biological motifs like zinc finger proteins. This provides a way to develop a qualitative methodology to screen for metal ions. Short peptides rich in histidine were synthesized using both solid phase peptide synthesis and SPOT synthesis on a cellulose membrane. Metal ions were introduced into the peptide solution, incubated, and washed to remove excess ions not coordinated with the peptide. Dyes that are dependent on metal ions to change color were used to detect if the metal ions were coordinated to peptide or washed off the peptide. This methodology was developed in solution and on a cellulose membrane. Problems still facing this methodology are that the dyes are not selective enough to discriminate between different ions and that the affinity between metal ions are peptides are too strong to donate ions to coordinate with dye. Our current work involves the use of self-assembling amyloids that are dependent on metal ions to perform catalytic esterase activity and their application in the sensitive detection of metal ions.

#22 - AUTOMATED INSECT DETECTION AND IDENTIFICATION SYSTEM. Jeff Dale, Radeeb Bashir, Robert Norton, Jiangfeng Pian, Roman Wisdom. Computer Science. Faculty Advisor: Dr. Razib Iqbal.

According to census.gov, five of the top ten Missouri exports come from the field of agriculture. As such, insect damage to crops poses a significant threat to Missouri's export revenue. To combat this problem, our team has engineered a system that uses cutting-edge technology in computer vision to detect, locate, and identify insects in video files. The system takes a user-provided video file as input and outputs the most confident insect match, an image of the insect the system believes to be in the video, and an image extracted from the video that the system determines to be the highest confidence match for the identified insect. The system also returns the second- and third-most confident matches, in the case that the first match was not correct. This allows the user to easily confirm the accuracy of the system before taking any action on the result. The system is implemented using OpenCV, a computer vision framework that can be extended to accept video streams, allowing agriculturalists to set up a live video stream for real-time insect information in their fields.

#23 - MULTIMEDIA DATA VISUALIZATION USING GOOGLE CARDBOARD. Mark Godsy, Ryan Jenkins, Andrew Byrd, Derek Hockett, Matthew Addler, Brent Eaves, Tara Walton. Computer Science. Faculty Advisor: Dr. Razib Iqbal

The Multimedia Data Visualization Using Google Cardboard project aims to present a flexible 3D modeling system that can be easily tailored with a variety of geographical and conservation data for the end users. Our proposed framework imports geographical location data and creates meshes to generate a 3D environment to explore using Google Cardboard. The software creates an interactive diorama of the environment for overhead view and exploration. The end user may also transition into an immersive environment where the geographical location data points can be experienced with wiki-style information at each data point. In this presentation, we will show that our software can be easily configured for use in other scientific disciplines, educational purposes, game design, and virtual tours.

#24 - OPEN SOURCE CLUSTER VALIDATION ANALYSIS PLATFORM IN PYTHON. Thy Nguyen and Jesse Stewart, Computer Science. Faculty Advisor: Dr. Tayo Obafemi-Ajayi.

We are living in the age of big data. Clustering is important and fundamental to the discipline of machine learning and data mining. Clustering algorithms are data exploratory tools that separate a finite, unlabeled data set into a finite and discrete set of natural, hidden data structures. The aim is discover natural groupings in the unlabeled data and assist us to see overall patterns in data that we may otherwise miss. For a given clustering algorithm, multiple results can be obtained on the same dataset by varying the algorithm parameters. Cluster validity refers to formal procedures to evaluate clustering results in a quantitative and objective fashion. Cluster validation metrics enable us to evaluate clustering quality to determine which clustering configuration best fit the data. The goal of our project is to develop and implement an open source graphical user interface cluster validation platform for evaluating varied cluster algorithms. It includes commonly used clustering techniques and validation metrics. It also supports operations on data sets such as scaling, input filling, and plotting. It offers not only rigorous tools for data analysis but also an intuitive graphical user interface that makes it easy for researchers to run experiments on multiple data sets.

#25 – BICLUSTERING OF GENE EXPRESSION DATA WITH BARTMAP. Jeff Dale, Computer Science and Applied Mathematics. Faculty Advisor: Dr. Tayo Obafemi-Ajayi.
Biclustering is an unsupervised data mining technique originating from clustering, which is currently widely applied in bioinformatics and medicine, particularly in gene expression profile analysis. Biclustering is an extremely powerful tool in detecting local patterns within a set of input data, whereas clustering is capable of detecting mainly global similarities. Gene expression data is often represented as a matrix whose rows are genes, columns are samples, and entries are expression levels of corresponding gene and sample combination. Biclusters in this data consist of a subset of rows and a subset of columns in which all entries exhibit similar behavior. BARTMAP (Biclustering ARTMAP) is an extension of the widely used neural network classifier Fuzzy Adaptive Resonance Theory (ART). Fuzzy ART is a fast and stable learning algorithm. Currently, BARTMAP is sensitive to order of presentation of samples. The goal of this research project was to translate BARTMAP from its original MATLAB implementation into an open source Python implementation with a graphical user interface, as well as to improve the BARTMAP algorithm itself to obtain more optimal and stable biclustering results. We empirically analyze our algorithm using synthetic datasets with pre-assigned biclusters and three real gene expression datasets: Leukemia, SRBCT and Scleroderma.

#26 - HUMAN POWERED BICYCLE GENERATOR. Jeremiah Fox, Freeman Lee, and Andrew Campbell. Electrical Engineering. Faculty Advisors: Dr. Rohit Dua, and Dr. Theresa Odun-Ayo.
The idea for our senior project came from the question, how do you interest the younger generation into entering the Electrical engineering field? The premise of the project was to design a simple system that would be easy to explain. The project demonstrates power generation and what affects can be seen when introducing different loads, along with other fundamental concepts that most people are not exposed to. The design can be compared to a power grid. The generation comes from the kinetic force applied from the pedal power to the rotor of a redesigned induction motor now acting as a generator. This then is sent through a transformer to step up the voltage to a useable house hold 120v range. A switchable load bank is then in use allowing an interactive feature to the project. This will show a direct relationship between physical exertion (RPM's) and electrical output. Metering such as: frequency, voltage, and current at various points in the system will allow the user to calculate the power they are producing.

#27 - DIGITAL ANALOG COMPOSITE MUSICAL SYNTHESIS, Misha Zarins**,** Sam McGoon**,** Electrical Engineering. Advisor: Dr. Rohit Dua**.**
Completing a fast fourier transform analysis of individual musical notes shows their component frequencies and respective amplitudes. The goal of the project was to emulate a piano tone using digital and analog electronic components. Light dependent resistors were used with operational amplifiers to create Schmitt Trigger switches. The output of the Schmitt triggers inputs into an FPGA development board through an 8:3 encoder. The FPGA then uses as clock signal at 50MhZ and divides it down into the specific frequencies we need. These frequencies are sub-harmonics that will sum together to replicate a piano note. After the signals leave the FPGA, integrator operational amplifiers convert the square wave signal into a saw-tooth waveform as a low-pass filter. The final signals are then summed from one last amplifier into a speaker. A final fast fourier transform was done on our signal to compare the results from our creation versus an analog piano. The final result shows that frequency spectrum was comparable to the piano spectrum however the sound was not similar due to the timbre of the piano and sine waves versus saw-tooth waves.

#28- TABLETOP MICROGRID: GENERATOR SYNCHRONIZATION AND VARIABLE LOAD APPLICATIONS Alex Heilman, Jeff Chapman, Joshua Sirb. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua

With the vast majority of the world's population connected to the power grid, many consumers who have instant access to electricity have taken it for granted. Consumers in the United States, in particular, have become accustomed to this fact and often fail to understand the intricacies of power generation and transmission. The use of multiple three-phase generators is a common practice to service loads that would otherwise exceed the capacity of a single generator. This concept became the primary learning objective of the Tabletop Microgrid, namely, the behavior of two generators in synchronism. In addition, the concepts of high voltage transmission, variable balanced loads, and power factor correction can all be examined. An instruction manual replete with basic experimental procedures is provided such that power-focused undergraduate students can explore these real world concepts. This project addresses just a handful of pertinent topics intended to prepare students in the electrical engineering discipline for a career in the power industry.

#29 – CURVALICIOUS. Chris Eakins, T.J. Orlandi, David Vernier. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua

It is crucial for electrical engineering students to have a firm grasp on semiconductor theory, but the electrical test equipment used to visualize these theories and properties can be very expensive. The scope of this project is to design and construct a function IV curve tracer for diodes and small signal transistors to assist in semiconductor theory education for future students of the Missouri State and MS&T cooperative electrical engineering program. Implementing a device such as an IV curve tracer allows for a visual method of interaction with semiconductor theory, an often times difficult theory to visualize. The project has two main parts; a GUI program to control the device as well as the physical circuitry in order to facilitate and obtain the needed readings to form an IV curve. A DAQ is being used to interface these two components and will require a USB connection with a computer running Windows. Power to the curve tracing circuit is to be obtained via a standard 120 VAC wall outlet.

#30 - SOUND TO LIGHT: TRIGGERED RGB LEDs WITH SPECIFIC FREQUENCY BANDWIDTHS USING AUDIO INPUT SIGNALS-TECHNOLOGICAL TOOLS FOR EDUCATION Karalyn Walker, MinhHoang Bach, and Tyler Noyes. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua.

Sound to Light is the name of a collaborative project that started as an idea for a frequency analyzer utilizing LEDs that evolved to inspire young minds with one of the most fundamental concepts used in all STEM fields. The project's aim is to create an educational tool to teach the waveform characteristic of frequency. The design used high Q filters that allow for frequency detection in the human audible frequency range of 20 Hz to 20k Hz. The filters detect from an audio input signal with cut-off frequencies at voltages that input into peak detectors that give a comparator high/low outputs which trigger LEDs. Future systems could use a variety of input signals from different sources to give a visual demonstration of frequencies of the source's waveform that incorporates kinesthetic and visual learning for an interactive way to engage learners. The results have shown audio frequencies ranges that were either passed because it was within the desired range or rejected due to being at a lower or higher frequency range than the desired frequency. This allows learners to experiment with audio sound and correspond it to a LED specific to a frequency range.

#31 - AUTONOMOUS OBJECT DETECTION AND REPOSITIONING ROBOTS.
Nathaniel Kelly and Meghan Sims, Electrical Engineering. Faculty Advisor: Dr. Rohit Dua.
Two autonomous mobile robots work simultaneously to retrieve and move objects to a targeted position. Each robot has a robust design that includes a chassis, a gripper, four mecanum wheels, ultrasonic sensors, and a microcontroller. If time allows the two robots will communicate through wireless communication devices. First, the robots create a map of the environment by using their ultrasonic sensors as they follow the perimeter of the environment. The map is generated as a matrix and stored inside the microcontroller's memory. The ultrasonic sensors detect environmental boundaries, arbitrary obstacles, and targetable objects, each type of object is initially assigned a 1 within the matrix, but those numbers will later be changed to number corresponding to the type of object. The robot then approaches a targetable object and repositions it based on a given target location, such as the corner of the arena. Currently, the project is still in development. Creating the map and communicating through the wireless communication devices are still being developed. After the map has been completed, the robots will know where objects are so they can detect and reposition them.

#32 - DECONSTRUCTED SWITCH MODE POWER SUPPLY.
Alex Cook, Calvin Roebuck and Carter Knuckles. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua.
The foremost concept of a Switch Mode Power Supply (SMPS) is the ability to adjust output power dependent on the amount of load applied to the power supply. For example, a PC while sitting idle draws a sufficiently smaller amount of power than it does when used heavily, running graphics, producing sounds and processing information. The SMPS can adjust its output power and deliver the power required. This equates to a very efficient and compact power supply compared to its predecessor, the linear power supply. Since the SMPS is very compact, part of the project is to deconstruct the device and divide it into several sub systems. In this case the SMPS will receive the line voltage from the wall outlet, which is 120 volts Alternating Current (AC) and produce available outputs of 3, 5 and 12 volts Direct Current (DC). The overall goal for the project is to design, build and implement a deconstructed SMPS that is capable of supplying power to numerous devices.

#33 - DEFINING THE RELATIONSHIP BETWEEN URBANISM, DOMESTIC-VIOLENCE REFUGE PRESENCE, AND DOMESTIC VIOLENCE OCCURANCE. Tim Datema, Michael Ruether, Geography, Geology, and Planning. Faculty Advisor: Dr. Ron Malega.
This research examines the effects of numerous variables on the occurrence of intimate partner violence/ domestic violence (IPV/DV) in Missouri. Combining new data with data from more than 15 other studies, this research combines multiple variables to examine how they affect the amount of domestic violence occurring within a region in unison. Surrounding the primary variables of urbanism and domestic violence shelter presence, other variables referring to neighborhood effects are analyzed on a spectrum of rural, semi-urban, and urban to examine the effects these neighborhood effects have on domestic violence occurrence. Levels of urbanism, combined with domestic violence shelter presence and local law enforcement strength were calculated into ratios to be compared with the numbers of domestic violence incidents within three counties in Missouri each representing a rural, semi-urban, and urban area. Producing mixed results, this research uses its findings to act as a basis for future analysis of domestic violence, its causes, and prevention initiatives.

#34 - NACIMIENTO GEOLOGIC ANALYSIS. Stuart Ennis, Brandon Lewis, Brandie Oehring, Skylar Scarrow. Geography, Geology and Planning. Faculty advisor: Dr. Matthew McKay

Northern New Mexico is part of the Colorado Plateau region and consists primarily of Mesozoic age sedimentary strata. During the construction of the Rocky Mountains, these rocks were uplifted and deformed. To characterize the local geology and investigate these mountain building processes we conducted reconnaissance geologic mapping and structural analysis west of Santa Fe, New Mexico. Rock lithologies, structural orientations of bedding, and the location and orientations of outcrop-scale faults, folds, and joints were collected throughout the mapping area. These data were used to create a geologic map that includes observed and interpreted geologic structures. The resulting map was used to construct a length-balanced cross-section and palinspastic reconstruction to restore rocks to their orientations prior to deformation and estimate the amount of shortening that occurred during Rocky Mountain deformation. These results provide insight into the area's structural geology and regional tectonic features.

#35 - SHORTENING OF THE NACIMIENTO MOUNTAINS. Zach Collette, Brad Dishman and Deriq Dooley, Geography, Geology and Planning. Faculty Advisor: Dr. Matthew McKay

Field geologic mapping provides insights into the local geology of an area and aids subsurface interpretation of local geologic structures. In northern New Mexico, west of Santa Fe, sedimentary strata of the Colorado Plateau were deformed in a series of Mesozoic mountain building processes that affected the western United States. In order to locate and characterize geologic structures in the southern Nacimiento mountains, we conducted field geologic mapping to collect structural orientations of dipping sedimentary strata, lithologies, and joints to locate folds and faults. The data was then used to construct a geologic map and length balanced cross-section of the subsurface geology. We use this cross section to restore the section to its length prior to deformation and estimate the amount of shortening that occurred in this area.

#36 - CONFIRMATION OF AGE IN STRATA FOUND IN THE BRANSON AREA USING MICROFOSSILS Deriq Dooley. Geography, Geology and Planning. Faculty Advisor: Dr. Charles Rovey

The Ordovician-Mississippian boundary in southwest Missouri is generally thought as the contact between the Cotter Dolomite and Bachelor Formation. However, previous Missouri State University students have found Mississippian-age conodonts (a type of microfossil) within the top of a 1.25 m limestone layer directly beneath the Bachelor Formation (a sandstone). This limestone layer overlies typical dolomite of the Cotter formation. Four samples were collected from within and below this limestone layer along the Branson Airport Road to confirm that the entire bed is Mississippian age, and to isolate the true Ordovician-Mississippian boundary. The samples were dissolved in a 15% Formic acid solution, each submerged for approximately one week. Afterwards, the samples were sieved and further processed via heavy liquid concentration and magnetic separation. Each sample was then scoured for conodont fossils. Samples were identified to the genus taxonomic level, and photographed multiple times at differing intervals of focus and composited into single high-resolution images. Many diagnostic Mississippian genera were recovered from the limestone bed, while Ordovician-age conoform elements are abundant within the underlying dolomite. The local Ordovician-Mississippian boundary occurs below the Bachelor Formation, meaning that the underlying limestone bed is indeed Mississippian in age, despite occurring below the aforementioned contact.

#37 – MANGROVE THREATS AND CONSERVATION IN GALLEON FISH SANCTUARY, SOUTH COAST JAMAICA. Josh Hess, Geography, Geology and Planning. Faculty Advisor: Dr. Robert Pavlowsky

Mangrove forests provide many functions for healthy coastal ecosystems. Mangroves function as sediment traps to prevent coastal erosion and protect coral reefs, physical barriers to storm waves, habitats for juvenile fish and benefits for education and tourism. In general, threats to mangrove forests include sea level rise, harvesting, pollution, wave attack and storm surges, and shoreline erosion. This study examines the threats to mangrove forests along the south coast of Jamaica in Galleon Fish Sanctuary near Black River in St. Elizabeth, Jamaica. The main threat was found to be the loss of mangrove wetland area due to shoreline erosion caused by sea level rise and storm wave attack. Global warming is predicted to increase hurricane intensity and storm wave heights in the Caribbean. Local community groups are implementing mangrove restoration programs in Galleon to off-set these losses. The threats of sea level rise on mangroves can help be mitigated by allowing the mangrove forests to move further inland with the rising sea and in order for this to happen effective land management and planning must be enacted.

#38 – GEOLOGIC MAP, CROSS-SECTION, AND STRUCTURAL ANALYSIS OF THE MARK TWAIN NATIONAL FOREST. Ian Shephard, Kaitlin Evans, and Tanner Merz. Geography, Geology, and Planning**.** Faculty Advisor: Dr. Matthew McKay.

Field geologic mapping provides basic information about the distribution of the local geology at the surface. Geologic maps can be used to create a geologic cross-section of the local area that provides information of how the subsurface geology. In the Springfield Plateau of Southwest Missouri, Ordovician-Mississippian-aged strata are relatively flat lying. We conducted a field survey to collect rock lithologies, measure bedding orientations (strike and dip), and find the approximate locations of map-scale faults and folds in Mark Twain National Forest. The data was used to create a geologic map and geologic cross-section in the mapping area. Faulting dissects the mapping area, with the Reeds Spring Formation juxtaposed directly against the Cotter Dolomite Formation along a normal fault with approximately 20 meters of displacement. This deformation is the result of epeirogenic uplift of the Ozark Plateau and the cause of off-set strata located in this area of the Mark Twain National Forest.

#39 – BEACH EROSION ALONG THE SOUTH COAST OF JAMAICA. Gregory Kelly. Geography, Geology and Planning. Faculty Advisor: Dr. Robert Pavlowsky

Beach erosion in Jamaica is occurring due to sea level rise, ocean warming, increasing intensity of storms, loss of mangrove habitat due to rising oceans, and human activities such as theft of sand by resorts. This study explores beach erosion problems along the south coast of Jamaica using information from published sources and field trips to Montego Bay, Treasure Beach, Bluefields Bay, Galleon/Black River, and Negril in March 2017. Many locations are losing beach area since natural sand supply is not enough for replacement. I spoke with many Jamaicans about their perspectives on beach erosion. They had mixed views. Some were not concerned about the problem. However, others were very passionate about the subject and explained how beach loss is happening very quickly, therefore damaging ecosystems and tourism prospects for business in the future.

#40 - ATTITUDES ABOUT RASTAFARI INFLUENCE ON JAMAICAN CULTURE. Jared Blau, Geography, Geology and Planning. Faculty Advisor: Dr. Robert Pavlowsky.

Jamaica is the birthplace of Rastafari and since its beginnings in the 1930's, the two have gone hand in hand. The movement was one of the biggest factors in identifying Jamaican art and culture as we know it today by separating it from British colonial culture. To explore Rastafari's cultural impacts, I took a trip to Jamaica and asked followers and non-followers about what Rastafari meant to them and what influence it has on Jamaican culture. While Rastafarianism is viewed as a religion, it is most strongly associated with providing a basis for a way of life. Its belief system and practices change depending on with whom you are speaking, but all will agree that it centers on following Jah (God) and Ethiopian Emperor Haile Selassie.

#41 - GEOLOGIC AND ENVIRONMENTAL FEATURES HIGHLIGHTED IN JAMAICAN ART. Tessa Mills, Geography, Geology, and Planning. Faculty Advisor: Dr. Robert Pavlowsky

Natural landscapes and their components influence culture. However we often overlook this aspect when we are in countries different from our own. This study shows how geologic and other environmental features are portrayed in art and crafts along the south coast of Jamaica. Not only are landscape paintings including nature common, but there are numerous wooden carvings that depict the environmental elements. While in Jamaica, I interviewed a local artist, Jah Calo, about his interpretation of the natural world through his art. For him, as well as others, art is a reflection of their way of life and living in such a beautiful place shows in their artwork. Landscape elements common to the Jamaican artists included mountains, beaches, and the ocean. Wildlife and marine subjects are also prevalent. Further, art themes that centered on geologic areas also happened to be tourist attractions. Economically, art and craft sales are important to local artists. In all areas of the south coast, especially along the beaches, you will run into someone trying to sell their crafts to tourists.

#42 - CONODONT EXTRACTION AND BIOSTRATIGRAPHIC ANALYSIS AT CEDAR GAP MISSOURI Brad Dishman, Geography, Geology and Planning. Faculty Advisor: Dr. Charles Rovey.

The Ordovician-Mississippian boundary in southwest Missouri is traditionally placed at the base of the Bachelor Formation, which overlies the Cotter Dolomite in most exposures. However, previous student research at Missouri State University has shown that a thin limestone bed beneath the Bachelor in the Branson, Missouri area has Mississippian-age conodonts. Recently a similar limestone bed was found beneath the Bachelor Formation near Cedar Gap, Missouri. These rocks were sampled starting just below the Bachelor Sandstone and extending downward into (Cotter) dolomite. Samples were crushed, washed, and digested in a formic acid solution and the insoluble residue was processed with heavy liquid and magnetic separation techniques to isolate the phosphatic conodont elements. The heavy non-magnetic fraction was picked for conodont fossils, which were identified and photographed. Fragments of diagnostic Mississippian-age conodonts were recovered from the uppermost sample immediately below the Bachelor, but the lower samples contained Ordovician genera only. These results show that Mississippian-age limestone strata are present beneath the Bachelor Formation at multiple locations in southwest Missouri. However, Ordovician-age limestones are also present within the upper Cotter Formation. Therefore, the stratigraphic sequence near the Ordovician-Mississippian boundary is more complex than previously recognized in southwest Missouri.

#43 - ASSESSING CORAL REEF THREATS AND REMEDIATION TECHNIQUES ON THE SOUTH COAST OF JAMAICA. Madalyn Behlke-Entwisle, Geography, Geology, & Planning. Faculty Advisor: Dr. Robert Pavlowsky.

Coral reefs play an integral role in the environment, economy, and society of Jamaica. Reef systems face a distinct set of threats from both local and global sources including tourism, overdevelopment, pollution, sedimentation, overfishing, and boat and diver disturbances. Global climate change is increasing sea temperatures resulting in ocean acidification and coral bleaching. This study examines reefs along the south coast of Jamaica near Treasure Beach and Black River in St. Elizabeth and Belmont in Westmoreland to evaluate their condition, main threats they face, and success of reef remediation projects. Coral affected by nutrient inputs from rivers was often overgrown with algae. The shallowest and most accessible reef examined was more degraded than the others. Artificial reefs and coral nurseries were examined in Bluefields Bay and Galleon Fish Sanctuaries. While issues like coral bleaching and algal overgrowth are problematic, it was found that the main inhibitor to healthy reefs and successful reef remediation projects is poverty, which results in insufficient funding for projects, lack of flexibility to avoid sensitive areas, and inadequate education about coral reefs.

#44 - ASSESSING THE LINK BETWEEN SYSTEMATIC JOINTS AND STREAM ORIENTATION IN SOUTHWEST MISSOURI Bennett Conway, Rachel Jackson, and Alexander Koch. Geography, Geology and Planning. Faculty Advisor: Dr. Matthew McKay

Bedrock geology is the main control on the development of surficial features, including the orientation of streams. By investigating the orientation of structural features in southwestern Missouri, we seek to explore over the local relationship between topography, stream flow, and structural features (faults, folds, and joints). Southwestern Missouri is located on the Ozark Plateau, where strata are very shallow to almost flat-lying. Local streams dissect the plateau, cutting through Mississippian limestones, chert, and clastic rocks. With little dip variation, if any structural control is present, it is likely related to systematic, tectonic joints (fractures). We observed approximately 2 joint sets, a NE-SW set (045-225°) and a NW-SE set (115-295°). To assess the relationship between tectonic joint systems and topography, we focus on stream orientation as a proxy for larger-scale topography. We present a model for stream orientations in the area of interest and compare the stream flow directions with that of our observed joint sets. This correlation will provide insight into surficial stream flow and may aid in understanding fluid flow in the subsurface.

#45 - STRUCTURAL ANALYSIS OF THE OUACHITA MOUNTAINS

Dalton Breeding, Kory Beck, Emma Gibson, Ashley Gerik, Zach Matthews, Geography, Geology and Planning. Faculty Advisor: Dr. Matthew McKay

To better constrain the basic geology, geologic structures, and investigate Paleozoic deformation in central Arkansas, we conducted 1:24,000 scale geologic mapping to the west of Caddo Gap. To conduct our analysis, we integrated the orientation of dipping sedimentary strata (i.e. stike and dip), rock lithologies, and outcrop-scale fold observations to construct a geologic map. In our mapping area, there are three thrust sheets separated by east-west striking thrust faults. These thrust sheets form ridges made of Arkansas Novaculite. Valleys are generally composed of mudstone and shale, which serve as detachment units for this thrust system. We also observed small-scale folding associated with the detachment of each thrust sheet. These folds were largely north-vergent, indicating the direction of tectonic transport. Furthermore, small-scale folding is often analogous to larger, map scale folding. To assess the subsurface architecture, a geologic cross-section was constructed from our geologic map. This cross-section was length balanced and used to generate a palinspastic reconstruction, to estimate the amount of contractional deformation in the map area, and assess the approximate distances of tectonic transport during regional orogenic events.

#46 - DETERMINING THE TECTONIC LINK BETWEEN THE OZARKS AND OUACHITA MOUNTAINS USING STRUCTURAL JOINT ANALYSIS. Allison Abbott, Emma Cochran, and Simin Wu. Geography, Geology and Planning. Faculty Advisor: Dr. Matthew McKay.

The Ozark Mountains of southwestern Missouri and northwestern Arkansas reflect a plateau dissected by local river systems, as opposed to traditional mountain ranges that are created by tectonic uplift, like the Ouachita Mountains of Arkansas and Oklahoma. There are, however, faults, folds, and tectonic joints in Ozark rocks that suggest influence of a mountain building event. To test this link, we examine the orientations of joints and structures found in southwestern Missouri Paleozoic strata and compare them to the stratigraphy and joint orientations of the Ouachita Mountains of western Arkansas. Our data from Busiek State Forest, south of Springfield show major joint sets that are oriented NNW–SSE (ranging from 340–160° to 000–180°). Minor joint sets were also resolved at 330–150° and 010–190°. North of Springfield, major joint sets range from 040°-220° to 060°-240°, with a wide range of minor joint orientations also present. The joint sets measured in Busiek State Forest correspond with the 340–160° to 000–180° and 000–180° and 020–200° joint set measurements from the Ouachita Mountains to the south. We, therefore, suggest that local jointing in the Ozarks may be related to Ouachita mountain building processes.

#47 – PETROLOGY AND GEOCHEMISTRY OF THE MINERAL CREEK AND LAST CHANCE ANDESITES, WESTERN MOGOLLON-DATIL VOLCANIC FIELD, SOUTHERN NEW MEXICO. Brandie Oehring and Shannon P. Rentz. Geography Geology and Planning. Faculty Advisor: Dr. Gary Michelfelder

The Mineral Creek and Last Chance andesites located in the western Mogollon Datil Volcanic Field (MDVF) of southern New Mexico are indistinguishable in hand sample. These units are regionally extensive throughout the Mogollon Mountains and are some of the stratigraphically youngest intermediate composition volcanic rocks in the MDVF. These andesites are monotonous medium-K, calc-alkaline rocks with 52-58 wt.% SiO_2 and display similar major element abundances. Trace element and Sr isotopic ratios suggest three unique populations characterizing the two andesite formations: a high Sr concentration, low $^{87}Sr/^{86}Sr$ ratio group of andesite representing the Last Chance Andesite, (2) a low Sr concentration, high $^{87}Sr/^{86}Sr$ ratio andesites and (3) a low Sr concentration, low $^{87}Sr/^{86}Sr$ ratio basaltic andesites both representing the Mineral Creek andesite. The Mineral Creek andesite has been dated at 25.0 Ma. Lava flows contain phenocrysts of plagioclase, CPX and rare olivine. The Last Chance andesite has been dated between 25.0 to 23.2 Ma. Basaltic andesite and andesite lava flows are crystal-poor with plagioclase > oxides +olivine and CPX. Here we present a working geochemical model to decipher the relationship of the two units are related to bimodal magmatism associated with the Mogollon Datil ignimbrite flare-up.

#48 - DROP BY DROP: THE PRICE OF WATER IN THE U.S. HOTEL INDUSTRY. Julia Bliss, Rachel Bower, Abbey Brinkley, Zach Bruckerhoff, Hannah Chu, Hospitality Leadership. Faculty Advisor: Dan Crafts

In recent years, the word "sustainable" was not well known in the hotel industry and a lot of confusion surrounded what it meant. Now, sustainability has become a significant trend in the hotel industry and will continue to be in the future (Tuppen, 2016). Making efforts to be sustainable will save our planet as well as save hotels money. Utilities are one of the biggest expenses for a hotel. According to the 2015 report, *Trends in the Hospitality Industry*, electricity is reported as the highest utility cost for a hotel at 60% of the total bill while water accounts for 23.8% of the total (Mandelbaum, 2015). There are innovative ways to cut utility costs on a hotel's monthly expenses and reduce the use of natural resources. Managers should be concerned about the cost of water, know the reality of its scarcity as a natural resource, and act to use only what is absolutely necessary for daily operations. This research reviewed innovative techniques that can be implemented in hotel departments to help reduce water usage and ultimately the cost of water to the hotel. The departments reviewed included housekeeping, food and beverage, engineering/maintenance, landscaping grounds, outdoor/indoor pools and spas.

#49 – WASTE TO REVENUE: ANALYZING SUSTAINABLE HOTEL PRACTICES. Micah Mason, Carley Nickel, Olivia Pahic, Kaylee Pecher, Mike Pugh, Hospitality Leadership. Faculty Advisor: Dan Crafts

Every hotel manager is in need of generating additional income, but not many realize they should start by looking at their trash. This research on waste to revenue in hotels creates a new alternative to generating additional income while also caring for the environment. The main focus points of this research were trash reduction, recycling, food waste management, electricity energy conservation, and HVAC maintenance. Each focus point can be modified to fit various hotel segments to save the hotel money either through diminishing bulk, or replacing outdated items with energy efficient machinery. The results of this research show that the transformation for companies could be challenging and create extra work, but the operational savings and increased profits will speak for themselves when hotel companies begin to see upward movement in profits and reductions in maintenance demands. Not only is this good for the hotel company's profits as a whole but managers can become a leader in protecting the environment

#50 – SUSTAINABLE CONSTRUCTION IN THE LODGING INDUSTRY. Rebecca Rice, Carly Sherman, Alec Shlater, Morgan Schuette & Zachary Stonecipher, Hospitality Leadership. Faculty Advisor: Dan Crafts

Sustainability and construction innovation in the lodging industry has become more relevant in recent years. Hotel guests are wanting to stay at properties that are green and or LEED certified that respond to all of their travel needs. It is the job of hotel managers and hospitality leaders to make sure that guests' expectations are met while at the same time managing their hotels in a sustainable manner. Throughout this paper the research focused on an in depth analysis of innovative ways to help a property attain green or LEED certification as well as provide amenities that catch the attention of the guest's eye. The research also reveals information that has been utilized by hotel professionals and design experts on how innovative processes and appliances work to save a substantial amount of day-to-day operational expenses as well as long term capital expenditures for lodging operations. The research demonstrates that when hotel managers implement these practices and amenities into their property they will be more sustainable.

#51 – RIGOROUS MATHEMATICS TEACHING: EXAMINING THEINTERPLAY BETWEEN CONTENT KNOWLEDGE AND PEDAGOGICAL CONTENT KNOWLEDGE. Symantha Campbell, Aubrey Hormel. Mathematics. Faculty Advisor: Dr. Patrick Sullivan

What are the nature of understandings a secondary teacher needs to have to develop students who can reason about geometry at a high level? Most practicing secondary mathematics teachers (n = 16) who participated in our study have the necessary content knowledge to successfully complete cognitively demanding geometry tasks. However, these same teachers struggled to create instructional experiences leading to many of students being unable to complete the same cognitively demanding tasks. Our study examined the nature of teachers' content knowledge and pedagogical content knowledge and how these may contribute to this disconnect. Analysis of teaching episodes of these same teachers suggests that these factors may include: 1) the structure of their mathematical knowledge, 2) their perception of what mathematical knowledge constitutes, 3) the cognitive demand of the tasks given to students, 4) the teacher holding students accountable to using correct mathematical language, 5) the nature of teacher questioning, and 6) nature of reasoning in which students are held accountable.

#52 – AN INVESTIGATION OF 2-DISTANCE SETS IN TWO, THREE, AND FOUR DIMENSIONS. Adam Somers, Mathematics. Faculty Advisor: Dr. Les Reid.
Given four points in the plane, a priori there are six possible distances between them. However, the four vertices of a unit square only have two distances: 1 (the length of the four sides) and $\sqrt{2}$ (the length of the diagonals). In this presentation, we completely determine all possible configurations of four points in the plane, five points in space, and six points in hyperspace having the property that there are exactly two distances that occur between them. We also describe avenues for future research.

#53 - GLOBAL STABILITY ANALYSIS OF ZIKA VIRUS DYNAMICS. Hayley Hutson and Savannah Bates. Mathematics. Faculty Advisor: Dr. Jorge Rebaza
The very few mathematical models available in the literature to describe the dynamics of Zika virus are still in their initial stage of development, and they were in part developed as a response to the most recent outbreak that started in Brazil in 2015, which has also confirmed its association with GuillainBarre Syndrome and microcephaly. The interaction between and the effects of vector and human transmission are a central part of these models. This work aims at extending and generalizing current research on mathematical models of Zika virus dynamics by providing rigorous local and global stability analyses of the models. In particular, for disease-free equilibria, appropriate Lyapunov functions are constructed using a compartmental approach and a matrix-theoretic method, whereas for endemic equilibria, a relatively recent graph-theoretic method is used. Numerical evidence of the existence of a transcritical bifurcation and some other simulations using Matlab are presented.

#54 – IMPROVING EFFICIENCY AND RELIABILITY OF TWITTER DATA. Daniel Ayasse, Mathematics. Faculty Advisor: Dr. Matthew Wright.
Each day, there are roughly 400,000,000 tweets published which raises the question, what is the most efficient way to store this data? Huffman coding is designed to create a variable length code based on the frequencies of symbols in a large sample text. However, with Twitter data, we need to look at more than just character frequencies. We also need to consider the frequencies of emojis and words. The most frequent characters, words, and emojis are stored with fewer bits while the infrequent symbols are stored with more bits. The resulting code is much more efficient than the standard ASCII encoding system. The saved space can then be used to implement a Reed Solomon error correction code that can correct up to a certain amount of errors. The ultimate goal of the new code is to minimize storage space while maintaining a reliable code that can correct errors when they occur.

#55 - DEVELOPMENT OF A SOL-GEL TiO_2 BUFFER LAYER FOR PEROVSKITE SOLAR CELL APPLICATIONS. David Beckwitt and Christopher Case. Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Mahua Biswas

TiO_2 compact thin film was developed on fluorine doped tin oxide (FTO) coated glass substrate, and investigated for a Perovskite solar cell application using a chemical solution process method. A highly compact electron-selective TiO_2 buffer layer is cost effective, easy to fabricate, enhances the efficiency of the cell by promoting electron mobility, and reduces recombination effects. Anatase crystalline phase is preferred due to its large band gap. The solution was made via the sol-gel method using proper mixture of Ti precursor titanium isopropoxide, ethyl alcohol, nitric acid and DI water. The TiO_2 thin film was spin casted on the solar cell substrate (FTO coated glass) followed by annealing at 600°C for developing an anatase phase crystalline film. The structural and elemental properties were analyzed using X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM). Post SEM results indicated cracking in the film surface, which will result in shunt current through the film, and poor electron extraction from the perovskite layer while designing the solar cells. This work focuses on the analysis of cracking ostensibly related to the stoichiometric ratio of the solvent: solutes and the different annealing conditions of the TiO_2 compact layer on the solar cell substrates.

#56 - SEARCHING FOR FREQUENCY MULTIPLETS IN THE PULSATING SUBDWARF B STAR PG 1219+534. John Crooke. Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Michael Reed.

Subdwarf B (sdB) stars represent the stripped cores of horizontal branch stars. Pulsating sdB stars allow us to probe this important stage in evolution. Thanks to Kepler data, we now know that sdB star rotation periods are long; on the order of tens of days. This explains why they were not measured using ground-based follow-up data, which typically only spanned a week or two. Azimuthal pulsation degeneracies are removed by rotation, and so by detected pulsation frequency multiplets, we can determine pulsation modes and apply constraints to models, which tell us stellar structure. We need the ground-based observations as Kepler did not detect many p-mode pulsators, but rather almost exclusively g-mode pulsators. The shorter-period p-modes occur in hotter sdB stars, and so we need these to measure the pulsation dependence across the horizontal branch. During 2015, we observed PG 1219+534 (hereafter PG1219) over several months using our local 16 inch robotic telescope. Here we report preliminary results of processing those data to search for pulsation multiplets.

#57 - COMPUTATIONAL INVESTIGATIONS OF HYDROUS ALUMINOSILICATE MELTS. Jesse A. Underwood. Physics, Astronomy, and Materials Science. Faculty advisors: Robert Mayanovic, Ridwan Sakidja

Water dissolution plays an important role in modifying the physical properties of silicate melts, thereby directly impacting upon the eruptive power of magmas in volcanoes and the mass transfer associated with magmatic processes. Studies of water-melt interactions at the atomic level will lead to a better understanding of the water cycle and plate tectonics on Earth, which is useful to help constrain habitable zones of rocky exoplanets. In the past, there were no detailed structural data of hydrous (i.e., with soluble water) silicate melts. Synchrotron high energy x-ray diffraction measurements have been made by our group of an albite melt in contact with water to high pressures and temperatures in order to obtain structural information on the system. This new structural data provided motivation to explore water-melt interactions and the atomistic structure of the hydrous albite melt using molecular dynamics (MD) simulations. In this work, we discuss our large simulation-cell MD calculations being carried out using ReaxFF potentials to accurately model water-melt interactions and to make a detailed quantitative structural determination of the hydrous albite melt system.

#58 - K2 OBSERVATIONS OF THE HYBRID SUBDWARF B PULSATOR PG0048+091, Laura Ketzer, Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Mike Reed
During Campaign 8 of the extended Kepler mission (K2), NASA's space telescope observed the pulsating star PG0048 continuously for three months with one minute integrations. On this poster we show the results of our analyses of these data and compare them to ground-based shot-term observations published in 2007. With K2's amazing coverage, we have uncovered several interesting features, most in contrast to the 2007 publication. PG0048 seems to be a hybrid pulsator with pressure modes probing the envelope of the star and gravity modes probing deeper into the core. This allows us to test for differential rotation and make inferences about the internal structure of the star.

#59 - EXOPLANET TRANSIT TIMING VARIATIONS WITH KEPLER SPACECRAFT DATA. Shannon Dulz. Physics, Astronomy and Material Science. Faculty Advisor: Dr. Mike Reed.
The Kepler spacecraft detected thousands of exoplanets over its mission lifetime by measuring the transits of these planets in front of their host stars. However, an initial processing of the data may be unable to detect additional non-transiting exoplanets in the systems. These additional planets may be measured by their effect on the transit timings of transiting planets. Using Kepler data, we search for transit timing variations of several known exoplanets which could reveal the presence of unseen additional planets. Once the transit timings are known, we phase fold the lightcurve to look for secondary eclipses, the signatures of the planet passing behind its star, which could be used to measure the temperature of the exoplanet.

#60 – MICRONERVA: GUIDING TECHNIQUES FOR AN AUTOMATED TELESCOPE ARRAY. Ryan Hall. Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Peter Plavchan.
MICRONERVA (MICRO Novel Exoplanet Radial Velocity Array) is a project designed to measure spectroscopic radial velocities with a system of 8 inch CPC Celestron telescopes. Our goal is to show that MICRONERVA has the effective light gathering power of a single, larger telescope for a lower cost. Light from each telescope is centered and focused on the entrance of a single mode fiber. Then, multiple fibers from multiple telescopes are combined at the exits of the fibers and sent through to one spectrograph. Focusing on more specific aspects of my project, this paper discusses the various programs and techniques that will allow individual telescopes to guide on targets. Each telescope must constantly keep starlight centered on the entrance to its single mode fiber for the time needed to obtain the spectrum. This will maximize the amount of light coupled into the fiber and sent to the spectrograph. The process of guiding will be done with the use of SBIG, ST-I guide cameras. The hardware is controlled using Python commands and the ASCOM and MaxIm DL drivers. The ability to guide on a target, with sufficient accuracy, is a crucial step that will determine the viability of the MICRONERVA project.

#61 – MODELING THE ROLE OF HEMODYNAMIC FORCES IN THE FORMATION OF SMOOTH MUSCLE CELL (VSMCS) AROUND PROXIMAL ARTERIES

Eiad Hamwi, Physics, Astronomy, and Materials Science. Faculty Advisors: Dr. Ridwan Sakidja, PAMS and Dr. Ryan Udan, Biology.

Proximal arteries and distal capillaries have been previously shown to possess different blood flow rates resulting in varying differential hemodynamic forces in wild type embryos [Udan et. al., 2013]. Thus, there has been a great interest in understanding the molecular mechanisms and signaling pathways that would respond to these hemodynamic forces. Since there has been evidence to indicate a preferred accumulation of smooth muscle cells around the proximal arteries, we are developing a simple physics-based model that would illustrate the mechanisms of the smooth muscle cells to migrate toward the proximal arteries versus distal capillaries with an initial assumption that the signaling strength is relatively proportional to the magnitude of hemodynamic forces, and by extension, the blood flow rate in the vessels. Through a parametrization of the signal strength as determined by proximity to the vessels, different density patterns of migrating vSMCs cells could possibly be identified. The topology map of such density patterns may be utilized further as a complementary diagnostic tool to support the experimental analyses.