

**#1 - DIETARY SUPPLEMENTATION WITH GRAPESEED EXTRACT PREVENTS DEVELOPMENT OF TRIGEMINAL SENSITIZATION AND INHIBITS PAIN SIGNALING IN A PRECLINICAL CHRONIC TMD MODEL.** Cody Likens, Lauren Cornelison, Sara Woodman, Chloe Keyes. Biology. Faculty Advisor: Dr. Paul L. Durham.

The goal of this study was to investigate the effect of dietary supplementation of grapeseed extract on the development of a sensitized trigeminal system and pain signaling in a chronic TMD model caused by prolonged jaw opening, an event that might occur during routine dental or orthodontic procedures. Mechanical nocifensive thresholds over the masseter were determined in male and female adult Sprague Dawley rats (naïve, muscle inflammation + jaw opening, GSE + muscle inflammation + jaw opening). Some animals received 0.5% solid MegaNatural-BP Grape Seed Polyphenol Extract (GSE) dissolved in their drinking water. Muscle inflammation and near maximal jaw opening in males increased the average number of nocifensive responses to mechanical stimuli over the masseter for 21 days but returned to near baseline levels by day 28. However, in females, muscle inflammation prior to jaw opening promoted persistent mechanical sensitivity 28 days post jaw opening. Daily inclusion of GSE significantly suppressed development of a sensitized state and inhibited pain signaling in response to prolonged jaw opening. Our findings provide evidence that dietary supplementation with GSE can prevent trigeminal pain signaling and thus could be useful in the management of TMD and other orofacial pain conditions involving trigeminal sensitization and activation.

**#2 – OPTIMIZATION OF GRAPE SEED EXTRACTION FROM CHAMBOURCIN GRAPES: USE AS DIETARY SUPPLEMENT TO INHIBIT PAIN SIGNALING IN CHRONIC TMD MODEL.** Chloe Keyes and Camron Satterfield. Biology. Faculty Advisor: Dr. Paul L. Durham.

Results from our laboratory have demonstrated dietary inclusion of a commercially available grape seed extract (Healthy Origins) was sufficient to inhibit pain signaling and reduced the level of inflammatory proteins in a model of temporomandibular joint disorder (TMD). The commercial product made by Healthy Origins utilizes a high-pressure water extraction process and a filtering system to enrich for polyphenolic compounds with low molecular weights. Polyphenols are potent antioxidant and anti-inflammatory compounds that are highly beneficial to human health. The goal of our study was to optimize the extraction process for enrichment of polyphenolic compounds from pressed grape seeds and skins from Chambourcin grapes donated by the MSU Fruit Experiment Station. Grape seeds and skins were homogenized in different solvents to determine which solvent would yield the highest concentration of polyphenols as measured using the Folin-Ciocalteu method with gallic acid as the standard. The grape seed extract was then used as a dietary supplement dissolved in the drinking water of Sprague-Dawley rats and found to inhibit pain signaling to a similar level in a chronic TMD model as seen with the Healthy Origins product. Future studies will be directed at increasing the quantity of polyphenol-enriched seed and skin extract from Chambourcin.

**#3 – INVESTIGATION OF CONNEXIN AND PANNEXIN GENE EXPRESSION IN A PRECLINICAL MODEL OF CHRONIC TMD.** Hannah Childs, Sara Woodman, Lauren Cornelison. Biology. Faculty Advisor: Dr. Paul L. Durham.

Chronic pain, which is characteristic of prevalent orofacial diseases including migraine and temporomandibular disorders (TMD), is commonly associated with tension, strain, or overstimulation of neck and shoulder muscles. Chronic temporomandibular joint pain results in cellular changes in the trigeminal ganglion (TG) and spinal trigeminal nucleus (STN). This pathological state involves changes in the expression of connexin and pannexin genes, which play a role in gap junction (direct cell to cell communication) and hemichannel formation (paracrine signaling). To investigate their possible role, connexin and pannexin mRNA levels in the STN (CNS tissue) and TG (PNS tissue) from male Sprague Dawley rats were determined in a chronic TMD model mediated by neck muscle inflammation and prolonged jaw opening. Tissue samples were collected 21 days post jaw opening and used for RNA isolation, cDNA synthesis, and qPCR. The mRNA levels of connexins and pannexins in the STN were down regulated in TMD animals relative to naïve levels, while in the TG most connexins and both pannexins were elevated. Findings from my study provide evidence that mRNA levels of connexins and pannexins are differentially regulated in the STN and TG in a chronic TMD model, and thus likely contribute to the underlying pathophysiology.

#### **#4 – INVESTIGATION OF CHANGES IN CYTOKINE LEVELS IN A PRECLINICAL MODEL OF CHRONIC TEMPOROMANDIBULAR JOINT DISORDER.** Sophia Antonopoulos and Lauren Cornelison. Biology. Faculty Advisor: Dr. Paul L. Durham.

Temporomandibular joint disorder (TMD) is a prevalent orofacial disease associated with chronic pain because of sensitization and activation of the trigeminal system. Having a better understanding of the cause and risk factors associated with this disorder can lead to improved treatment options. I hypothesize that cytokines levels in the upper spinal cord will be differentially regulated in our model of chronic TMD pathology. Male and female adult Sprague-Dawley rats were subjected to muscle injections and prolonged jaw opening, which promotes development of a chronic pain state. Upper spinal cord tissues were collected at day 35 for untreated naïve animals and sensitized animals subjected to prolonged jaw opening. Using a proteomics cytokine array of 29 cytokines known to modulate inflammation and pain signaling, the level of multiple cytokines was consistently elevated or decreased in our TMD model when compared to levels in naïve animals. Female animals had a greater number of positively regulated cytokines compared to males. Results from this study provide evidence that cytokine levels in the upper spinal cord are both positively and negatively modulated in response to prolonged jaw opening and thus are likely to play a role in the sustained sensitization observed with our chronic TMD model.

#### **#5- CAN QUANTUM DOTS INHIBIT THE GROWTH OF CANCER CELLS: HeLa?**

Basant Hens. Biology. Faculty Advisor: Dr. Kyoungtae Kim

Quantum dots (QDs) such as CdSe/ZnS and InP/ZnS are nanoparticles emitting various wavelengths of fluorescent light depending on their size, which allows them to be exploited for *in vivo* sensing/imaging of cancer cells. Even with their benefits, thorough assessments on these commonly used QDs are essentially required prior to their full applications. To this end, I investigated the effects of Cd and In QDs on the growth of the human cervical cancer cells (HeLa). My XTT assay results showed that InP/ZnS caused more robust proliferation inhibition of HeLa cells than CdSe/ZnS did. This study also revealed that smaller green CdSe/ZnS exerts more toxic effects than slightly larger yellow CdSe/ZnS, consistent with the notion that smaller QDs are more toxic than larger ones. Further research will entail investigations of potential causes of the growth defect with QDs by measuring oxidative stress and levels of apoptosis. My long-term research goal is to analyze transcriptome profile changes in response to QD treatment.

#### **#6 – A COMPARISON OF THE EFFECTS OF SILVER AND CADMIUM**

**NANOMATERIAL ON BAKER'S YEAST.** Cullen Horstmann, Daniel Kim. Biology. Faculty Advisor: Dr. Kyoungtae Kim.

The objective of this study is to determine and compare the toxicity of Ag nanoparticles and CdSe/ZnS quantum dots (QD) on yeast. We conducted a cell membrane stability assay, proliferation assay, and ROS assay to help determine each nanomaterial's relative mechanism of toxicity. In the cell membrane stability assay we determined that exposure to AgNPs caused a faster drop in yeast O.D. than CdSe/ZnS QD exposure. The proliferation assay determined that AgNPs had more of an effect on the growth curves, which can be visualized with decreasing concentrations of AgNPs. CdSe/ZnS QD exposure had little effect on the growth curves at varying concentrations. The ROS assay determined the amount of ROS present in yeast that were treated with AgNPs and CdSe/ZnSQDs and the percent ROS levels found were similar in both Ag and CdSe/ZnS treated samples. We also conducted an RNA Seq to identify differentially expressed genes in yeast treated with Ag and CdSe/ZnS nanomaterials. Upregulated genes were found to be involved in RNA processing and ribosomal biogenesis, and downregulated genes were found to be involved in metabolism and cell wall stability.

**#7 – DYNAMIN-ASSISTED PROTEOLIPOSOME FUSION.** Onika Olson, Jared Smothers, Ehsan Suez, and Sravya Rallabandi. Biology. Faculty Advisor: Dr. Kyoungtae Kim.

SNARE proteins mediate membrane fusion between the Endosome and Golgi. The vesicular SNARE (v-SNARE) Snc2 combines with the target SNARE (t-SNARE) complex composed of Tlg2, Tlg1, and Vti1 to create an active SNARE multiplex. The “zippering” of the assembled SNARE complex is thought to provide the force necessary to draw two opposing membranes into close enough proximity to destabilize and fuse the separate bilayers into one membrane. While many types of SNARE containing liposomes have been able to effectively recreate fusion events *in vitro*, inter Golgi and Endosome-to-Golgi SNAREs have been shown to require additional factors for fusion. We utilized an *in vitro* fusion assay using FRET techniques to measure the fusion efficiency of Endo-TGN SNAREs in the presence of Vps1, a dynamin like protein. For this, recombinant SNARE proteins were purified and reconstituted into liposomes containing fluorescent NBD and Liss-Rhodamine lipids. Dynamin is a GTPase that plays an important role in clathrin-dependent endocytosis as well as possible vesicle trafficking to and from the Golgi. To test GTP requirement, Vps1 was incubated with different combinations of SNARE proteins, GTP, and a GTPase inhibitor called dynasore.

**#8 – EFFECTS OF ALTERNATIVE CHEMOTHERAPEUTIC AGENTS ON THYROID CANCER** Husref Rizvanovic and Hanna Williams. Biology. Faculty Advisor: Dr. Kyoungtae Kim

Matrix Metalloproteinase 2 (MMP2), an extracellular matrix protein, is expressed in many cancers. It is known to be associated with metastasis and aggressiveness of several cancers. In our study we used ML-1 thyroid cancer cells that express MMP2. ML-1 cell line is derived from an aggressive follicular thyroid cancer, which has dedifferentiated and metastasized. Although differentiated thyroid cancer is amenable to current therapies, dedifferentiated cancers become resistant to current therapies and thereby offer poor prognosis. There is currently an unmet need for better therapeutic agents in this scenario. This research reports the effect of Chlorotoxin and Saporin in MMP2 positive cells. Chlorotoxin, a well-known MMP-2 agonist, is conjugated with the ribosome-inactivating protein, Saporin, to effectively reduce the viability of ML-1 thyroid cancer cells *in vitro*. We hypothesize that this conjugate will effectively inhibit the proliferation of the thyroid cancer cells.

**#9 – MYOSIN V-MEDIATED CARGO TRAFFIC TOWARD THE TRANS-GOLGI NETWORK.** Julia Villarreal and Anh Ly. Biology. Faculty Advisor: Dr. Kyoungtae Kim.

Myosin helps with the contractions of the muscles, as well as an essential vehicle for the transportation of cargo-laden vesicles. Myosin’s head uses the energy derived by hydrolysis of ATP to walk along the actin filament while its tail carries a vesicle destined to the final destination including the trans-Golgi network. Although defects of myosin-mediated cargo traffics are associated with many human disorders, the precise mechanism of Vps10 and Snc1 delivery to the trans-Golgi network remains poorly understood. We report here that myosin 2, a type V Myosin, plays a major role for the traffic and that two truncated myosin 2 species and 5 myosin point mutants display significant defects in the context of Vps10 and Snc1 cargo transport to the Golgi. Furthermore, in all these myosin 2 mutants Vps10-GFP cargo-carrying vesicles showed no noticeable movement as compared with wild-type cells, suggesting myosin 2 is essential for Vps10 traffic to the trans-Golgi network. The disruption in the cargo trafficking led to the hypothesis that the actin filaments may be compromised. Therefore, actin filament staining will show if actin filaments are broken into pieces or a continuous rod within the yeast cell

**#10 – UV-C LIGHT EXPOSURE AS A POSSIBLE TREATMENT METHOD AGAINST *PSEUDOGYMNOASCUS DESTRUCTANS* ON *MYOTIS SEPTENTRIONALIS* FIBROBLAST CELLS.** Susan Anderson. Biology. Faculty Advisors: Dr. Thomas Tomasi and Dr. Christopher Lupfer.

Since 2006, the *Pseudogymnoascus destructans* (*P.d.*) fungus, has caused devastating effects to native bat populations in North America, causing many bat species to become much more rare. Recently, it was discovered that the *P.d.* fungus is vulnerable to UV-C light because it lacks the UVE1 gene for nucleotide repair of UV damage. Because of this, using UV-C light is a possible treatment for bats infected by the *P.d.* fungus, as well as treating their habitats with UV-C light. However, little to no research has been performed on the possible effects that UV-C light would have on bats themselves. For this experiment, *P.d.* spores as well as fibroblast cells from Northern long-eared bats, *Myotis septentrionalis* were exposed to UV-C light at an estimated intensity of 10 mJ/cm<sup>2</sup> at exposure duration of 5, 15, and 45 seconds. As UV-C exposure time increased, both fungal and bat fibroblast cell death increased. Due to this, using UV-C light could be a possible source of treatment for bats if properly and carefully regulated.

**#11 - INVESTIGATING NOVEL PROTEIN INTERACTIONS IN NLRP3.** Karina Sewell. Biology. Faculty Advisor: Dr. Christopher Lupfer.

NOD-Like receptors (NLRs) are intracellular proteins that play an important role in the regulation of the innate immune response to pathogens. There are 22 NLR proteins encoded in the human genome. Specifically, NLRP3 can detect the presence of pathogens by recognizing cellular damage leading to the formation of a multi-protein complex known as the inflammasome. The inflammasome is responsible for activation of the Caspase-1 protein that ultimately leads to the activation of inflammatory cytokines IL-1 $\beta$  and IL-18. Mutations to the NLRP3 gene lead to autoinflammatory diseases. Even though we know the function of NLRP3, how it is activated and the proteins that it interacts with are still unknown. By creating a yeast two-hybrid system, we can discover novel proteins that interact with NLRP3. Determining these novel proteins will allow us to learn more about how NLRP3 is regulated and how the immune system works to fight off infection. We have previously discovered seven potential interacting proteins (such as PLSCR4) using this method and are currently in the process of examining the strength of their interactions with NLRP3.

**#12 - IDENTIFYING NOVEL NLRP7 PROTEIN INTERACTIONS.** Matthew So. Biology. Faculty Advisor: Dr. Christopher Lupfer.

The protein NLRP7 is a member of the NOD-like receptor proteins (NLRs). NLRs play important roles in our innate immune system in response to viral and bacterial infection, as well as cellular damage. Yet, while we are aware of 22 NLRs, we only know the functions of about half, many are pro-inflammatory, causing inflammation. These NLRs mediate the release of pro-inflammatory cytokines, like interleukin-1 $\beta$  (IL-1 $\beta$ ), by forming inflammasomes that activate caspase-1, cleaving pro-IL-1 $\beta$  into the active IL-1 $\beta$  that is then secreted from the cell to induce inflammation. Previous research indicates that NLRP7 possesses pro-inflammatory functions by responding specifically to bacterial AcLP, a component of bacterial cell walls. While this function is known, NLRP7 interactions with other cellular processes still needs to be explored. Research has shown a correlation with a mutation in the NLRP7 gene leading to recurrent molar pregnancies. Thus, we have developed a yeast 2-hybrid system to explore novel protein interactions with NLRP7 and a human cDNA library to see how it interacts with other human proteins. Once protein interactions of interest have been identified, we will confirm the interactions in human cells, shedding light onto the effects of NLRP7 on cellular processes.

**#13 - TOO MUCH *LACTOBACILLUS* CAN SPOIL THE WHOLE BATCH.** Shannon Pettus. Biology. Faculty Advisors: Brad Culbertson and Dr. Katy Frederick-Hudson  
*Lactobacillus* is a common spoiler of beer causing major loss for craft breweries. This research project is focused on *Lactobacillus* bacteria, one of the main bacteria responsible for contaminating and spoiling beer during production. The project evaluated the effect of alcohol concentration on the success of *Lactobacillus*. In order for results to be applicable for the brewery, the bacteria was isolated from a naturally contaminated sample taken at Mother's Brewing Company and beer with added ethanol was used as media. After propagation of the *Lactobacillus* culture, beer of varying alcohol concentrations of 5-13% was inoculated with three different volumes of the bacterial culture. We expected that as alcohol concentration was elevated, the success rate of the bacteria would decline. There are many factors that affect the survivability of this bacteria in a brewery and further research should be continued. This study could help inform the production efforts of craft breweries reducing the spoilage of product.

**#14 - THE DIVERSITY OF *BRADYRHIZOBIUM* AND NON-RHIZOBIAL ENDOPHYTES WITHIN THE ROOT NODULES OF SOYBEAN.** Femila Manoj, Scott McElveen. Biology. Faculty Advisors: Dr. Michael Burton and Dr. Babur Mirza.  
Soybean serves as a food crop, feed crop, and intercrop that enhances soil fertility by establishing symbiotic associations with nitrogen-fixing bacteria of the genus *Bradyrhizobium*, which reside in the root nodules of the host plant. Culture-based methods have suggested that members of the genus *Bradyrhizobium* are the dominant occupants of soybean root nodules, while other studies have also identified the presence of non-rhizobial endophytes. The extent and selection of non-rhizobial endophytic diversity within root nodules are unknown. The objective of this study is to assess the root nodule microbiome using NextGen DNA sequencing. The 16S rRNA genes of the microbial community from the root nodules of the soybean plants of two genotypes were sequenced to assess the diversity of *Bradyrhizobium* spp. and non-rhizobial endophytes. Sequence analysis reveals that *Bradyrhizobium*-related sequences were the most abundant taxa in both soybean genotypes analyzed, followed in abundance by *Nitrobacter* and *Tradiophaga*. Non-rhizobial endophytes were found inconsistently, and at lower abundances in all nodules sampled. These results suggest that soybean does not select growth-promoting bacteria for nodule occupancy.

**#15 - A TALE OF RAIN GARDENS: EVALUATION FIVE YEARS POST CONSTRUCTION** Teresa Aguayo. Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles  
Rain gardens are often placed in urban areas to collect stormwater runoff from surrounding impervious surfaces. This runoff can contaminate streams and cause localized flooding. Urban environments can benefit from rain gardens due to its aesthetic qualities as well as its ability to act as a filter for water, sediment, and pollutants. Previous research showed that rain gardens are effective in filtering runoff and absorbing water up to two years post construction. Rain gardens contribute to these functions through their strategic design, location, soil characteristics, and plant community composition. There are several rain gardens located in Springfield Missouri, which are all a part of the James River or Sac River watershed. These rain gardens were constructed five or more years ago and vary in physical and biological characteristics, which may affect their ability to collect and filter water. We measured depth, total area, ground cover, and soil organic matter content, particle size, and infiltration rates of these rain gardens. We compared soil infiltration rates and determined relationships with other characteristics of the rain gardens.

**#16 - IMAGE ANALYSIS SHOWS RELATIONSHIP BETWEEN BIOMASS AND AREA COVER.** Jordan Heiman, Trang Tran. Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles  
Dry biomass is often used to assess plant growth due to the inconsistencies of fresh weight measurements. It is determined by drying collected plant material in an oven at a constant temperature over time. This method results in plant material not being available for use in other analyses such as chlorophyll or DNA extraction. We developed a method using image analysis software to measure growth of *Lemna minor*, a free-floating aquatic plant, which is often used for toxicity testing. We collected images of *L. minor* plants of varying area cover and then dried them to determine dry biomass. Regression analysis showed that area cover was positively correlated with dry biomass. We used the subsequent regression equation to determine dry biomass from area cover. To compare this new method to the traditional method of drying plant material, we exposed *L. minor* plants to different concentrations of nutrients to assess differences in growth. After two weeks of plant growth, we collected images of plant area cover and then dried the plants to determine dry biomass. Findings of both methods showed similar results for dry biomass as determined by image analysis of area cover and by drying the plant material.

**#17 – TOXICITY OF SILVER NANOPARTICLES IN AN AQUATIC ENVIRONMENT.**

Trang Tran, Jordan Heiman. Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles.  
Silver nanoparticles (AgNPs) has long been used for industrial, medical, and household products due to its antimicrobial properties. With increasing usage, AgNPs can enter aquatic ecosystems via wastewater. Previous studies have found that AgNPs compromise the blood-brain barrier, damage DNA and protein structure, cause chlorosis, and have adverse effects on growth. We carried out toxicity tests using *Lemna minor* to determine the effects of chronic exposure to AgNPs. We used the floating aquatic plant *Lemna minor*, as the test subject because they are fast growing and excel at taking up nutrients and pollutants directly from water. Plants were grown for two weeks in nutrient solution with different concentrations of AgNPs (60, 125, 250, 500, 1000 µg/L). Plants grown in nutrient solution under the similar conditions without AgNPs served as a control. Inhibition of growth increased with increasing AgNPs concentrations. Plants exposed to 60 µg/L grew as well as the control group, while the higher concentrations showed increasing growth inhibition. Increasing concentrations of AgNPs adversely affected growth of *Lemna minor*.

**#18 – SEASONAL CHANGES IN AQUATIC VEGETATION IN SPRING-FED PONDS.**

Hannah Whaley. Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles.  
Wetlands are important to both wildlife and water quality. As well as providing food and habitat for wildlife, wetlands can act as filters to nutrients and pollution, can reduce flooding, and can be buffers between run-off and water bodies. Numerous wetlands have been destroyed for alternative uses such as agriculture and development. This is detrimental to local ecosystems and can have large impacts on water quality. Restoration of wetlands is an important step in helping negate these effects. However, human-made wetlands are susceptible to various problems. For example, human-made wetlands can be more susceptible to eutrophication due to their physical and chemical properties, hydrologic conditions, and watershed characteristics. Williams Pond is a spring-fed eutrophic pond at the George Washington Carver National Monument, in Diamond, Missouri. This pond contains both nuisance and invasive aquatic vegetation. We surveyed the pond seasonally to determine the changes in the aquatic vegetation community structure throughout the year. Physical and chemical data were also collected to determine relationships with the aquatic plant community. A survey of other similar spring-fed ponds will also be conducted to determine their physical, chemical, and biological characteristics and to better understand these systems and their function.

**#19 - WHAT ARE STUDENT ATTITUDES TOWARDS THE USE OF MATH IN GENERAL BIOLOGY?** Deanna Means, Tina Hopper. Biology. Faculty Advisor: Dr. La Toya Kissoon-Charles.

Students' interest, perception of usefulness, and cost of a task can influence their likeliness to succeed. We conducted two surveys in general biology for majors and non-majors to assess their attitudes towards the use of math in biology and their basic quantitative skills. We found that students demonstrated a decreasing interest in math and their views did not improve at the end of the semester. Students also demonstrated an increasing perception of the usefulness of math for their future careers and a higher perception of the cost of including math in biology courses. Biology majors had a higher interest in using math to understand biology and found it more useful than non-majors. However, both majors and non-majors showed similar perceptions of cost. Our assessment of student quantitative skills showed that majors scored higher in graphing and statistics questions compared to non-majors

**#20 - EFFECT OF A LARGE VOLCANIC ERUPTION ON MACROINVERTEBRATES IN HIGH ELEVATION ECUADOREAN STREAMS.** Patricia Blankenship and Nicholas Coppock. Biology. Faculty Advisor: Dr. Debra Finn.

Little is known about how volcanic activity affects streams. In 2015, the Cotopaxi volcano erupted as macroinvertebrate sampling was being concluded for another study. We evaluated the eruption's effect on taxonomic richness and population densities of a common mayfly (*Andesiops peruvianus*) by resampling eight of the previously sampled streams just after volcanic activity ceased in 2016. Streams were 4,000m asl and paired by basin: four on Cotopaxi, and four on a nearby inactive volcano. Each pair consisted of one stream fed by glacial runoff and another fed by groundwater. Of the four control and four Cotopaxi streams, only one stream showed sizeable declines in both taxonomic richness (from 12 to 2) and population density of *A. peruvianus* (from 951/m<sup>2</sup> to 0/m<sup>2</sup>): a glacial runoff stream on the southwest face of Cotopaxi. These results suggest that aspect and watershed size interacted to influence ecological impact. Prevalent easterly wind, and larger area of ash collection in run off streams likely caused a chemistry shift. In large quantities the ash negatively affected the diversity and population densities of macroinvertebrates.

**#21 – MOPHOLOGICAL VARIATION OF THE SNAIL *PLEUROCERA ACUTA* ACROSS A 6th ORDER STREAM NETWORK.** Jacob Means, Biology. Faculty Advisor: Dr. Debra Finn

Snails are abundant grazers in Ozark streams. Many snails exhibit intraspecific variation in shell morphology that is associated with position in the stream network or local habitat conditions. We tested whether morphological variation in *Pleurocera acuta* was associated more strongly with position in the stream network or local habitat conditions (i.e. depth, velocity). We collected samples of *P. acuta* from 15 sites ranging from 1st order to 6th order sites distributed throughout the North Fork White River drainage basin. We cataloged, photographed, and measured all *P. acuta* individuals for overall length and width, as well as the length of aperture using a stereoscope and ImageJ software. We observed a negative correlation between the length to width ratio ('skinniness') and the depth of the local habitat while nothing conclusive could be drawn from the position in the stream network. These results highlight the importance of local habitat conditions and suggest that shell morphology of *P. acuta* is a phenotypically plastic trait.

**#22 - SIZE DISTRIBUTIONS OF THE SNAIL *ELIMIA POTOSIENSIS* IN RESPONSE TO FLASH FLOODS IN AN OZARK STREAM, Vanessa Morales. Biology. Faculty Advisor: Dr. Debra Finn**

Flash floods completely remove organisms from streambeds. Ozark streams are highly flashy, but streambed communities recover quickly after floods, especially the algae-grazing snails *Elimia potosiensis*. We studied an Ozark stream and how snail populations recover following flow disturbance. We hypothesized that snails use the hyporheic zone, a habitat beneath streambed made of sediment and porous space, as a flow refugium. We monitored flow patterns and collected snails from Bull Creek, a stream just south of Springfield, regularly for one year. We compared flow patterns, snail abundance, and snail size distributions through time. Two bed-moving floods occurred during the study period. During approximately month after floods, snail abundance remained low (ca. 30 snails per  $m^2$ ), compared to pre-flood abundance (ca. 2367 snails per  $m^2$ ), and was dominated by small juveniles (ca. 3.7-5.4mm). It took approximately 80 days following floods for adult snails (ca. 6.1-11.0 mm) to re-appear, abundance never fully recovered to pre-flood levels during our study. It appears the hyporheic zone is an important, but size selective, refugium. In these unpredictable systems, the asynchronous development of *E.potosiensis* could be a key factor in resilience of population.

**#23 - MANGROVE RESPONSE TO EROSION AND HUMAN DISTURBANCE IN JAMAICA Taylor Emberton. Biology. Faculty Advisor: Dr. Robert Pavlowsky.**

Mangroves are important to the environment since they provide protection from floods, reduce erosion, create habitats for wildlife, and sequester carbon. However, mangrove forests along tropical coasts are threatened due to sea level rise, timber harvest, pollution, and coastal development. Understanding the present distribution and conditions of mangrove forests along coastal areas is an important first step toward developing conservation plans for them. This study evaluates the locations, conditions, and threats of mangroves along the south coast of Jamaica along Bluefields Bay and near Black River and Treasure Beach in St. Elizabeth. The species present and the conditions of their surrounding environment were documented in each area. It appears that beach erosion due to sea level rise and the clearing of mangrove forests are responsible for mangrove decline. In areas with large coastal marshes and lagoons and minimal human disturbance the mangroves flourish due to their natural resistance to high salinity water and acidic soils. Developing practices for the restoration of damaged mangrove forests could help prevent the loss of mangroves, ensuring they continue to benefit coastal ecosystems and local communities.

**#24 – JAMAICAN RIPARIAN FOREST COMPOSITION 40 YEARS AFTER A CATASTROPHIC FLOOD EVENT. Daniel Ruedin. Biology. Faculty Advisor: Dr. Robert Pavlowsky.**

Tropical forests are important for nutrient cycling and carbon sequestration and contain high biodiversity. After disturbance, forests follow a sequence of successional stages and eventually reach a climax community structure. Forest recovery can be affected by soil characteristics formed by the disturbance. This study assesses riparian forest composition along the Bluefields River in Westmoreland, Jamaica which was severely disturbed by a flood in 1979. Thirty six trees >6 cm diameter breast height were inventoried using the point quarter method at three different sites. One site was relatively unaffected by the flood. The second site was affected by deep flood flows and catastrophic channel erosion which left behind thin soil cover and exposed bedrock. The third site was affected by thick deposits of gravel and soil from debris flows generated by landslides in nearby mountains. The greatest importance value of tree species varied among the sites: (i) undisturbed site, cherry fig (*Ficus americana*) at 300.00; (ii) depositional site, Royal Poinciana (*Delonix regia*) at 115.96; and (iii) erosional site, almond (*Terminalia catappa*) at 133.18. The causes of these differences will be evaluated, but it is clear that forest recovery can vary along Jamaica rivers, even among relatively close sites (<1 km).

## **#25- DECOMPOSITION IN BURNED AND UNBURNED WOODLANDS OF THE OZARKS.**

Alexis VonBokel, Faculty Advisor: Dr. Alexander Wait.

The oak/hickory woodlands that surround the Ozarks were maintained historically by fire and grazing. Prescribed fire is used to keep the over-story canopy open (40-60% cover). To evaluate the effects of different fire regimes, researchers collect data in degraded unburned woodlands, woodlands being restored with burning, and woodlands that have an open canopy because of a long history of burning. The degraded woodlands have undergone mesophication meaning the canopy has closed and more mesic conditions exist where there is higher moisture and less light. This study looks at decomposition rates measured as rates of return of carbon to the forest floor relative to inputs. Leaf litter bags containing 10g of dry oak leaves were placed at degraded woodland not burned in over 50 years, recently burned woodland undergoing prescribed burns for restoration, and continuously burned woodlands that approach the cover of historical savannah. I measured the weight of the leaves after 31 days in decomposition bags and compared them to rates obtained fall 2011. Decomposition rates were higher in continuously burned than degraded woodlands in the fall, but the trends were reversed in the spring. Mesophication explains the trends in the data and suggests carbon inputs are relative to turnover.

## **#26 – COMPARISONS OF THE POTENTIAL DISTRIBUTION OF BLARINA IN MISSOURI.** Paige R. Harman, Biology. Faculty Advisor: Dr. Sean P. Maher.

Taxonomy, the classification and naming of organisms, is of conservation concern for management efforts. Conservation of a species relies on accurate taxonomic identification, such that erroneous records impede conservation and management. There are three species of short-tailed shrew, genus *Blarina*, in the United States: *B. carolinensis*, *B. hylophaga*, and *B. brevicauda*, with the latter two predominantly found within the central United States. Recent genetic evidence suggests that most individuals in Missouri are *B. brevicauda*, rather than *B. hylophaga*. Due to several morphological similarities between *B. hylophaga* and *B. brevicauda*, it is important to consider that records of *Blarina* could be misidentified. Using data from VertNet and EcoClimate, we constructed distribution models comparing suitability in Missouri and assessed whether we could discern taxonomic status of *Blarina*. Here we demonstrate that environments in Missouri are suitable for both species, but, perhaps, there is higher suitability for *B. hylophaga*. VertNet lacks significant sample sizes of both shrew species, and this perhaps impacted our results. Our models are not a panacea to delineate the shrew's specific identity, and would be better used to estimate a species geography. To accurately investigate taxonomic status of shrews in Missouri, additional fieldwork is imperative.

## **#27 - PREDICTING RANGE SIMILARITY AND MAINTENANCE FOR TWO SPECIES OF NEOTOMA.** Angelica Smith, Biology. Faculty advisor: Dr. Sean P. Maher.

Species are sensitive to climate and have specific habitat requirements, which combine to determine that species' geographic range and extent. Eastern Woodrat, *Neotoma floridana*, with established populations in Missouri, abuts the range of Central Plains Woodrat, *N. micropus*, southwest of Missouri. Past records of these species are used to assess historical climatic conditions and ranges. We can measure potential effect of climate change on the species' ranges and extent via species distribution and ecological niche models that include biotic, abiotic, and dispersal data. Here we address predictions of range similarity and maintenance of Missouri populations of *N. floridana* and *N. micropus*, and show increasing similarity of these species' ranges through comparisons of hindcast and forecast models. We found that the initial contact of *N. floridana* and *N. micropus* likely occurred between 21ka and 6ka. Future predictions show a range shift, either *N. micropus* expansion or *N. floridana* retraction, that minimizes hybridization. Within the context of Missouri, *N. micropus* is unlikely to invade and extirpation of *N. floridana* is improbable. This methodology can be used to forecast future ranges of species and estimate future interactions. Further, these results can inform management decisions and be used as testable predictions for future research.

**#28 -ASSESSING FERTILITY PATTERNS IN A CAPTIVE BREEDING POPULATION OF ALLIGATOR SNAPPING TURTLES.** Anthony Grate, Biology. Faculty Advisors: Denise Thompson and Dr. Day Ligon.

Global turtle declines have intensified during the past several decades and as a result many conservation initiatives use captive breeding as a means to restore populations and assure species survival. Despite this, turtle mating systems remain understudied and little is known about factors that influence reproductive success. The purpose of this study is to evaluate egg fertility patterns in the context of reproductive success in a captive breeding population of alligator snapping turtles (*Macrochelys temminckii*) housed in southeastern Oklahoma. I will use a technique known as oocyte-membrane bound sperm detection to quantify sperm densities in alligator snapping turtle eggs that either, 1) showed no signs of embryonic development, or 2) stopped developing during early incubation, in order to ascertain whether the egg had been fertilized or not. Eggs that have high sperm densities but showed little to no signs of development suggest that fertilization took place and early embryonic mortality was the cause of egg failure. Conversely, eggs that failed to develop and have little evidence of sperm will be inferred to be infertile. This research will contribute to a better understanding of the conservation challenges facing this and other species of turtles.

**#29 - THE EFFECTS OF HABITAT ON ANTIPREDATOR RESPONSES IN A CONFLICTING ODOR LANDSCAPE.** Sarah White, Biology. Faculty Advisor: Dr. Alicia Mathis.

Variations in the background environment can influence daily activities of individuals, such as the effectiveness of foraging and predator avoidance behaviors. For prey species that rely on visual crypsis, color of the background environment can be of particular importance. Rainbow Darters (*Etheostoma caeruleum*) are cryptic benthic fish that inhabit rocky-bottomed freshwater streams and are preyed upon by Banded Sculpin (*Cottus carolinae*). In our study, we manipulated the substrate color of captive darters so that they blended in (lighter-colored rocks) or stood out (dark mottled) from the background environment, then measured darter behavior following exposure to either a blank control or a sculpin scent cue. Because darters are sometimes sedentary, a food scent cue was introduced at the start of each trial to encourage activity. Darters responded to the predator cue with increased activity (fleeing) when they stood out against the dark-mottled substrate, but reduced movement (freezing) when they were more cryptic on the lighter-colored substrate. These results demonstrate that color of the substrate influences antipredator behavior of cryptic darters.

**#30 – EFFECT OF URACIL IN DIFFERENT SEQUENCE CONTEXTS ON 2D NMR PROPERTIES IN DNA.** Jaclyn Becker, Ben Boyd. Chemistry. Faculty Advisor: Dr. Gary A. Meints

Single base DNA lesions are known to correlate with cancer through mutagenesis if the lesions are missed in the process of base excision repair (or BER). DNA glycosylases play a key role in recognizing and excising these DNA lesions to prevent such mutations. Uracil can be present in DNA through the deamination of cytosine, which can cause a mutagenic mispair of U:G. Uracil can also be mismatched with adenine. In this project, one base in the Dickerson-Drew Dodecamer (DDD) has been replaced with uracil, and the U:G and U:A mismatches are being studied. The different base-pairing and sequence contexts for uracil create different chemical shifts that have been studied using 2D solution NMR techniques to study proton interactions as well as 1D temperature effects of <sup>31</sup>P. The data compares the changes in NOE intensity peaks in the modified sequences. The results indicate significant differences between the uracil-containing sequences and the control DDD sequence.

### **#31 - NMR ANALYSIS OF THE EFFECT OF G-T MISMATCHES IN DIFFERENT SEQUENCE CONTEXTS ON <sup>1</sup>H/ <sup>31</sup>P CHEMICAL SHIFTS AND NOE INTENSITIES.**

Koby Ljunggren, Chemistry. Faculty Advisor: Dr. Gary A. Meints.

DNA lesion research is an evolving area of study to better understand the structures that often serve as the precursors to cancer through mutagenesis. In this project, the self-complementary G-T mismatch sequence d(C-G-C-G-A-A-T-T-T-G-C-G) and its precursor d(CG-C-G-A-A-T-T-MeC-G-C-G) are the primary targets for analysis. Both G4-T9 and G4-MeC9 are sequences that would occur in vivo due to spontaneous deamination of methylcytosine residues and DNA methyltransferase activity respectively. Another sequence of interest is d(C-G-C-G-G-A-T-T-C-G-C-G), a G5-T8 mismatch. This sequence presents a G-T mismatch at an analogous position to another sequence of interest. Through 2D solution NMR techniques, changes in intramolecular DNA behavior may be observed. Utilizing NOESY connectivities, the G4-T9 sequence was analyzed by comparison to a standard Dickerson-Drew Dodecamer (DDD) and G4-MeC9 precursor. <sup>31</sup>P melting curves for the G4-T9 mismatch and εA5 lesion were also compared. Chemical shift differences were determined for each sequence relative to the DDD. Localized changes in DNA structures and intramolecular properties were observed near the site of the lesions

### **#32 - COMPUTATIONAL MODELING OF THE FIRST COMMITTED STEP IN THE PHENYLPROPANOID PATHWAY.** Michela E. Rollins, Chemistry. Faculty Advisor: Dr.

Matthew R. Siebert

The phenylpropanoid pathway is responsible for the biosynthesis of many important compounds in plants such as flavonoids, lignin, and phenylpropanoids, all of which are crucial to a plant's growth and development. The first biosynthetic step in the phenylpropanoid pathway is phenylalanine ammonia lyase (PAL) mediated conversion of L-phenylalanine to *trans*-cinnamic acid. This conversion is thought to proceed through an E1<sub>cb</sub> mechanism, however, empirical data suggest it may be on the border between E1<sub>cb</sub> and E2. Herein, we will present our efforts at computational modeling of this conversion as well as other common elimination mechanisms. Discovering the specific mechanics of this PAL-mediated reaction has a number of applications. For instance, PAL may be used in therapy for phenylketonuria patients, providing a substitute enzyme for the patient's mutated PAH enzyme. The PAL enzyme has also been shown to exhibit properties which are suitable for environmentally conscious industrial biosynthesis of non-natural amino acids such as 2-chloro- and 4-trifluoromethyl-phenylalanine derivatives.

### **#33 - GROWING YOUR GIANT, REDESIGNING THE ORGANIC CHEMISTRY TWO LAB.** Jeremiah M. Ukena, Chemistry. Faculty Advisor: Dr. Matthew R. Siebert.

Science has been described as "dwarfs standing on the shoulders of giants" where individual scientists (dwarfs) work to extend the collective knowledge of all scientists that have preceded us (the collective "giant"). It is the goal of the chemistry department to train the next generation of scientists, so that they may sit on the shoulders of the giant. We must, then, remember that the giant is always growing: more and more discoveries are collected into the giant with each passing day. In this project, the aim is to develop experiments for use in Missouri State University's CHM 445 (Benchscale Organic Chemistry Laboratory) course. These experiments will be designed to: 1) better reflect the scale on procedures for research in the field of organic chemistry (e.g., "separating whiskey flavoring compounds"), and 2) reflect cutting-edge technology in the field of organic chemistry (e.g. "a Ni-catalyzed Suzuki-Miyaura coupling"; chemistry that won the 2010 Nobel Prize in Chemistry). We will describe our efforts in locating, carrying-out, and generating pedagogical materials for several experiments.

**#34 - LEARNING ORGANIC CHEMISTRY: A PEN AND PAPER APPROACH.** Daryl Meyer. Chemistry. Faculty Advisor: Dr. Matthew Siebert.

The university sophomore organic course is one of the most daunting in the education of an undergraduate student. Researchers have identified many reasons for difficulty, and many different pedagogical styles have been employed to try to alleviate some of the difficulties from students. This project attempts to address the latter. A student/researcher was to create worksheets to aid classmates with learning the material. Worksheets were created and distributed via Blackboard Learn, but there were difficulties in having the material available before the exams that covered the material. In the first semester course, it is suggested that supplying supplemental study materials was able to influence exam grades. However, it was a most overwhelming task for a researcher to take on this project while enrolled in the class as a student who was trying to initially learn the material.

**#35 - RHENIUM MANGANESE SILICIDE POWDER X-RAY DIFFRACTION.** Daryl Meyer. Chemistry. Faculty Advisor: Dr. Fei Wang

This experiment makes ternary compounds of varying proportions of rhenium and manganese with silicon. A total of five compounds were mixed, melted, scanned by powder x-ray diffraction, annealed, and diffracted again. Diffraction patterns were then refined and analyzed in reference to the binary compounds of  $\text{MnSi}_{1.75}$  and  $\text{ReSi}_{1.75}$ . Ternary compounds retained the  $\text{ReSi}_{1.75}$  cell parameters throughout the transition from  $\text{ReSi}_{1.75}$  in the major phase to  $\text{MnSi}_{1.75}$  in the major phase.

**#36 - A RHEOLOGICAL STUDY ON THE TEMPERATURE DEPENDENCE OF VISCOSITY FOR THERMORESPONSIVE POLYMER SOLUTIONS.** Jessica Bruer, Chemistry. Faculty Advisor: Dr. G. Alan Schick.

Many active pharmaceutical ingredients (APIs) are poorly soluble and make for inadequate drug absorption. Soluplus<sup>®</sup>, a thermoresponsive tri-block graft copolymer, is a commercial excipient (BASF Corp) that enhances the solubility and bioavailability of many APIs. The mechanism of enhancement is related to the ability to form polymeric micelles in solution. These micelles store insoluble APIs in their hydrophobic interior and transport them to targeted sites in the body. An important characteristic of solubility enhancers is the particle size exhibited in solution before and after loading with APIs. This is most commonly determined by dynamic light scattering (DLS) methods. However, DLS measurements involving thermoresponsive polymer solutions can be complicated by the temperature dependence of viscosity, a solution property that directly impacts the size analysis algorithms of DLS. In this project, the temperature dependence of viscosity for Soluplus<sup>®</sup> solutions was evaluated and used as a correction to particle size measurements by DLS. Solution concentrations ranging 1% - 30% (w/w) of Soluplus<sup>®</sup> were studied from 15°C to 35°C using a cone-and-plate rheometer. It was found that as temperature increases, viscosity also increases, showing non-Newtonian behavior. By analyzing the temperature dependence of viscosity, the particle sizes of thermoresponsive polymer solutions can be more accurately characterized.

### **#37 - EFFECTS OF THE VARIATION OF THE PERCENT DEGEE (DIETHYLENE GLYCOL MONOETHYL ETHER) ON THE pH OF TOPICAL CREAMS**

Carajill Campbell, Chemistry. Faculty Advisor: Dr. G. Alan Schick.

Better solubilization agents in topical skin creams may lead to an increase in the array of available topical medicines. One such solubilizing agent is DEGEE, diethylene glycol monoethyl ether. Since the average natural pH of skin is around 5, and studies have suggested that the resident bacteria of the skin begin to disperse above a pH of 8, the pH of solutions put on the skin are of interest to researchers. The purpose of this study was to test the effect on pH of a cream when one varies the amount of weight percent of DEGEE. The creams tested were 20%, 15%, 10% and 5%. This study found that as the amount of DEGEE decreased, the pH decreased as well. This could be because more water in the cream recipe was able to react with the basic components of the cream at lower DEGEE values, thus decreasing pH. More research is needed to support this conclusion. The pH values found in this study associated with any of the DEGEE weight percent values did not stray far from the skin's average natural pH, with an average range of 5.03-5.81.

### **#38 – THE INTERACTION OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) AND CERIUM OXIDE NANOPARTICLES WITH WHEAT (TRITICUM AESTIVUM L.)**

Sarah Braun, Chemistry. Faculty advisor: Dr. Cyren M. Rico

Per- and polyfluoroalkyl substances (PFASs) have been recognized as a disruptive issue in environmental systems due to their persistence. The agricultural practice of using treated sludge and biosolids-amended soils from waste water treatment plants (WWTP) has been linked substantial contamination of per- and polyfluoroalkyl substances (PFASs). Municipal Landfills also harbor many products that contain PFASs and they have been reported as a landfill leachate due to their persistence. This study will investigate the impact of combined exposure of PFAAs and cerium oxide nanoparticles on toxicity in wheat (*Triticum aestivum* L.) grown in biosolids-amended soil. Total concentrations of cerium in wheat root, shoots and grains and soils will be analyzed via inductively coupled plasma mass spectrometry (ICP-MS). PFAAs will be analyzed by high-performance liquid chromatography coupled with mass spectrometry (HPLC-MS).

### **#39 – ANALYSIS OF HEAVY METALS IN SOIL USING ICP-MS.**

Brett Lottes, Stephen Sample, Michael Oluwasegun. Chemistry. Faculty Advisor: Dr. Cyren M. Rico.

Soil analysis was performed to determine the concentrations of several metals including Hg, Ag, Co, Ni, Pb, Cr, Tl, and Sb. Soil samples along with NIST Standard Reference Material (i.e. Montana soil) were prepared using EPA's digestion method 3051. Standards for calibration curve were prepared to analyze diluted samples using Inductively Couple - Mass Spectrometry (ICP-MS). Mass spectrometry was the preferred method because of its ability to detect extremely low concentrations (i.e parts per billion) and simultaneously analyze multiple elements in a single run. The concentration readings from the ICP-MS were then converted into their per mass of sample equivalent to reflect how much of each metal was present in relation to the overall mass of the sample. The experimental elemental concentrations obtained from the reference material were compared to the reported values to confirm the completeness of the digestion method.

**#40 - ANALYSIS OF METALS IN THE SOIL AND WATER NEAR RECYCLING FACILITIES AND INDUSTRY.** Stephen M Sample Jr, Dane C Wagner, Brett M Lottes, Oluwasegun M Abolade. Chemistry. Geology. Faculty Advisor: Dr. Cyren M. Rico  
River systems are a vital aspect of most ecological systems. Federal and State regulations dictate how soil and water systems are to be treated, especially when dealing with recycling facilities. Recycling facilities are also restricted in what they are allowed to process, as some facilities cannot handle items such as car batteries and certain metal alloys. If local recycling facilities are following regulations, then their proximity to local river systems should have negligible impact on the soil and water near them. Composite soil and total water samples were gathered from three locations at the Jordan Creek near a group of recycling facilities and industries in Springfield, Missouri. The samples were then acid digested and run through an ICP-MS for analysis. The metals analyzed were lead, zinc, copper, aluminum, chromium, iron, nickel, cadmium and magnesium. The metal concentrations of the soil and water were then compared to locations upstream and downstream of the recycling facilities, to determine if there is a significant difference between them. This could provide insight into the effectiveness of current environmental regulations and the results could lead to further investigation regarding the mobility of metals in the environment and its effect on local wildlife.

**#41 - CHANGES IN METABOLITES AND FATTY ACIDS IN WHEAT GENERATIONALLY EXPOSED TO CERIUM OXIDE NANOPARTICLES (CeO<sub>2</sub>-NPS).** Dane Wagner, Brett Lottes, Oluwasegun 'Michael' Abolade. Chemistry. Faculty Advisor: Dr. Cyren M. Rico

Many food crops are exposed to different types of nanoparticles today. Many of these nanoparticles come from anthropogenic sources and can have different effects on the plants' level of metabolites and fatty acids. In this study, the relative abundance of metabolites and fatty acids concentrations in wheat grains generationally-exposed to CeO<sub>2</sub>-NPs were analyzed. Results showed that after generational exposure to CeO<sub>2</sub>-NPs the relative abundance of some metabolites have significantly increased or decreased in the grains. Likewise, the overall fatty acid content decreased in generationally exposed wheat grains. Overall, these findings indicate physiological changes in wheat generationally exposed to CeO<sub>2</sub>-NPs that affected the grain quality.

**#42 - IMPROVING THE FUNCTIONALITY OF CARBON DOTS VIA DOPING AND FUNCTIONALIZATION.** Megan Prado, Chemistry. Faculty Advisor: Dr. Adam Wanekaya.  
Carbon dots are a class of carbon nanomaterials that exhibit unique properties such as multicolor emissions, photostability, low toxicity, and biocompatibility. These unique properties have enabled a wide range of applications ranging from cell imaging to photothermal therapy and photovoltaic applications. However, their properties and functionality still need to be improved in many aspects. One way of doing this is through doping and surface functionalization. Doping tunes the electronic properties of carbon dots while functionalization creates or changes surface states, thus influencing their solubility and applications. Here in, we demonstrate the tuning of electronic and optical properties of carbon dots via doping/co-doping with various atoms like B, N and S, etc. The functionality is demonstrated by modifying the surface of the carbon dots with different groups such as amine and carboxylic acid groups. Characterization will be performed through various techniques including X-ray Photoelectron Spectroscopy (surface groups), Dynamic Light Scattering Spectroscopy (particle sizing), Transmission Electron Microscopy (particle size and morphology), UV-vis Spectroscopy and Fluorescence Spectrophotometry (optical properties).

**#43 - SHEAR FORCE-INDUCED FLUORESCENT DYE TRANSFER BETWEEN BLOCK COPOLYMER MICELLES.** Giselle Campos, Chemistry. Faculty Advisor: Dr. Keiichi Yoshimatsu.

The premise of this research is to develop nanomaterials that alter optical properties in response to shear stress. In this work, the stability of PEG-PLA micelles was monitored by measuring Förster resonance energy transfer (FRET) efficiency. The DiO (donor) fluorophore was excited and transferred the energy to DiI (acceptor) fluorophore when in close proximity. The diblock polymer PEG-PLA micelles containing donor-acceptor fluorophore pairs were exposed to shear force for different periods of time. The results showed that, upon exposure to shear force, the FRET micelles exhibited noticeable changes in the fluorescence emission from the acceptor dye.

**#44 - COST-EFFECTIVE MULTIPLEX PROTEIN INTERACTION ANALYSIS METHOD BY USING MICROSCOPE-BASED LIQUID ARRAY.** Eathan Hickey, Chemistry. Faculty Advisor: Dr. Keiichi Yoshimatsu

A typical liquid array system utilizes polystyrene beads and a fluorescence cytometer for analysis of intermolecular interactions. The liquid array system holds several advantages over a planar array system that requires specialized planar glass or cellulose and that has proven to be very technically difficult, require specialized instruments, and consequently expensive. The method has been applied in broad areas including the characterization and optimization of protein ligands and the detection of diagnostically useful immune complexes. In this work, we aim to develop a new system that adapts the advantages of the liquid array system while achieving lower cost. The method uses different dye concentrations for ‘barcoding’ of the TentaGel beads, an inexpensive optical microscope, and an image analysis software.

**#45 - CELL PHONE ASSISTED DETECTION OF METAL IONS IN WATER BY PAPER-BASED ANALYTICAL DEVICES.** Chad Lakin II, Chemistry. Faculty Advisor: Dr. Keiichi Yoshimatsu.

This work focuses on the use of cell phone app and a paper-based analytical device (PAD) in the detection of metal ions in water samples. The PAD is set up to have six separate “wells” with five different metal ion-binding dyes and one control well in each respective PAD. The app utilizes the cell phone’s camera to take a picture of the PAD and quantify the intensity of the color produced by the sample containing metal ions. The picture is converted from a color image into a grayscale image, and then it digitizes the average intensity of specified areas. In order to compare the “pattern” of the color intensities for references and unknown samples, the app employs a pattern recognition approach. Our results showed that the app correctly identified the type of metal ions present in solution in all 60 trials.

**#46- FLUORESCENCE-BASED MONITORING OF BLOCK COPOLYMER MICELLE STABILITY UNDER DYNAMIC CONDITIONS.** Tyler Odom, Devin Mart, Chemistry.

Faculty Advisor: Dr. Keiichi Yoshimatsu.

Block copolymer micelles hold great potential in multiple application areas. The block copolymer micelles are formed *via* non-covalent interactions between individual polymer chains, and, therefore, are inherently ‘fragile’. However, the stability of micelles under dynamic conditions has often been underappreciated. The block copolymer micelles used in this work consist of polyethylene glycol-block-poly(lactic acid) block copolymer (PEG-*b*-PLA). Two structurally-related dyes, DiO and DiI, were incorporated into the hydrophobic core of micelles and the stability of micelles was monitored by fluorescence spectroscopy. Under a static condition, the micelle solution showed negligible fluorescence intensity change over two hours. In contrast, a large decrease of the fluorescence intensity was observed after vigorous vortexing. This proves the feasibility to monitor the shear force-induced breakdown of micelles by a simple spectroscopic technique. By utilizing this method, we investigated the kinetics of micelles breakdown under dynamic conditions.

**#47- SPECTRAL SIMILARITY OF COMPOUNDS WITH COMMON SUBSTRUCTURES USING FTIR.** Joshua Ellis, Computer Science. Faculty Advisors: Dr. Razib Iqbal and Dr. Keiichi Yoshimatsu.

Fourier-transform infrared spectroscopy (FTIR) is a spectroscopic method to obtain an infrared spectrum of absorption a chemical compound. The method allows for analyzing a given compound’s infrared spectral signature. In our research, we examine IR spectra to discover relationship between spectral signature and chemical structure. Since distinct chemical substructures will generally exhibit similar absorbance at a neighboring set of wavenumbers, we are looking into the use of these spectral waveforms and correlative models to analyze the common spectral signatures shared between compounds with a common substructure. Given that two or more compounds share a common substructure, we applied multivariate correlation to give a correlation value to the set of spectra at each wavenumber where the set spans. The product of these local correlation values and the average spectral absorbance at each given wavenumber produces the spectral contribution given by the spectral set’s common substructure. In this poster, we present that these spectral contributions for chemical substructures could be useful for future research into identifying the chemical structure of a compound from its spectral signature.

**#48 – AUTOMATED GRAPE LEAF PATHOGEN DETECTION AND QUANTIZATION USING CANNY EDGE DETECTION ALGORITHM AND CONTOUR MAPPING.**

Connor Jansen, Kyle Sargent, Alex Wilson, Colton Eddy, Emily Box. Computer Science. Faculty Advisors: Dr. Razib Iqbal and Dr. Laszlo Kovacs.

Image analysis, the process of taking an image, breaking it down into individual pixels and processing the properties of each pixel, is a powerful tool and one sought out by many scientists to process images in ways no human eyes could ever do, including tracking near microscopic levels of a pathogen. In this poster, we present an automatic Leaf Disk Analyzer to calculate the ratio of powdery mildew growth on grape leaves. We use a Canny Edge detection algorithm and contour mapping to quantify a ratio of a harmful pathogen, *Plasmopara Viticola*, to healthy grape leaves. Using the calculated ratios, scientists can track the pathogen’s growth over a length of time to determine resistance to the pathogen on a plant-by-plant basis. Our tool will aid researchers worldwide to prevent grape production loss and provide an inexpensive way to analyze other pathogens in the future as well.

**#49 - REAL-TIME PARKING SPOT FINDER USING VIDEO CAMERA FEED.** Dustin Clifton, Deven Colbert, Connor Elzie, John Guinn, and Savon Williams. Computer Science. Faculty Advisor: Dr. Razib Iqbal.

In this project, we present an interactive application to determine if there are available parking spaces based on video camera feeds. Using image segmentation and an artificial neural network, we mask both parking spaces and vehicles on multiple frames and then apply image processing to determine whether a given parking space is available or not. First, we outline the parking spaces and cars from multiple frames from each parking lot and color in those outlines. Then, we train a Neural Network with these images to detect these types of objects in other parking lots. After the Neural Network can determine parking spaces and cars, the image processing software will take the video footage and iterate through each frame to detect the status of each parking space. If the status of the parking space is available, then the parking space will be outlined in green and if the status is unavailable it will be outlined in red. We use SQLAlchemy database to store the status of each parking space. The web-based interface will have a list of all the parking lots with a percentage of available parking spaces. The users will be able to click on a lot to see the available parking spaces within that lot.

**#50 – PREDICTING EMOTION THROUGH VOCAL METRICS FOR SMART HOME ENVIRONMENTS.** Bryan Jones. Computer Science. Faculty Advisor: Dr. Razib Iqbal.

Automatic emotion recognition from speech is an interesting field of research due to the rise of smart home devices like Amazon Alexa and Google Home. Even though there are multiple other factors that go into determining emotion such as facial expressions and body language, but speech is the focus in this research due to its wide use in smart home applications. Our approach focuses on feature extraction from spoken words. We analyze the recorded audio samples based on pitch, sound pressure level (SPL), Mel-Frequency Cepstral Coefficient (MFCC), and the frequency of gaps between words to be used for prediction of one of three emotions; normal, happy, or angry. We used three machine learning algorithms (K-Nearest Neighbors, Neural Network, Multi-Layer Perceptron) and one decision tree algorithm (Classification Tree) to predict the emotions. Experiments with existing multilingual datasets demonstrated that K-Nearest Neighbor provided the best accuracy in terms of emotion detection.

**#51 – PORTABILITY AND PERSONALIZATION OF ELECTRONIC HEALTH RECORD.** Elliott Campbell. Computer Science. Faculty Advisor: Dr. Tayo Obafemi-Ajayi.

Currently in the United States, the transfer of electronic health (or medical) records (EHRs or EMRs) from one health system establishment to another is not seamless. Subsequently, it increases the time necessary to begin treating a patient at a different health system as well as the risks that the patient may face should the situation be urgent, and the inconvenience of the patient when being treated at a new facility. In this project, we propose a portable EHR system to aid in the transfer of a patient's EHRs across multiple system and implement a "proof of concept" prototype. The solution is a credit-card-sized smart card that contains an individual's personalized EHR that is easily readable and updated by legal medical professionals. To test the proposed solution, we attempt storing a synthetic health record on a test smart card. The format of the EHR is a JSON that follows FHIR standards. After compression and minimization, the file fits within the size limit of the chosen 64KB (512Kb) smart card and the info was able to be stored and read. This could impact the future transportation and reliability of data between unassociated hospitals, clinics, and pharmacies.

**#52– GOOD VIBRATIONS, OR HOW I LEARNED TO STOP WORRYING AND LOVE ANALOG.** Damien Burbage, Anna Buckthorpe, Chase Ruggeri. Faculty Advisors: Dr. Rohit Dua, Dr. Tayo Obafemi-Ajayi

Theremins are novel musical instruments, commonly used to make eerie sound effects. They work by exploiting small changes in capacitance between metal plates and the player's hand. To produce pitch, they use a system of 2 oscillators which have identical resonant frequencies. One of these oscillators is connected to a plate that functions as a capacitor, where the player's hand is a grounded plate. This introduces approximately 3000 Hz frequency swing. In order to produce that swing, the resonant frequency must be very high, on the order of 450000 Hz, well outside the audible frequency range. The signals from these oscillators are sent to a mixer which outputs the difference, which is in the audible frequency range. The volume is controlled by another oscillator with a variable plate capacitor. That signal is sent to a frequency to DC converter which uses a filter to attenuate the signal based on its changing frequency and a peak detector to turn the attenuated signal into a varying DC signal. The outputs of the mixer and the frequency to DC system are sent to a voltage-controlled attenuator, which outputs the 0-3000Hz signal set at the amplitude of the DC control signal.

**#53 – AUTOMATED RECYCLING SYSTEM USING PROGRAMABLE LOGIC CONTROLLER TO TEACH AND VISUALIZE DIGITAL LOGIC.** Kyle Akers, Jeremy Orf, and Adam Crabtree. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua.

The goal of this project was to build a physical device that students can interact with in order to develop an understanding of Programmable Logic Controllers (PLCs), automation, and digital logic. The system was designed to be a small-scale controlled version of industrial systems currently in real automated recycling plants. Students will be able to see how a PLC takes the digital logic instructions and translates them into physical, automated movements. The system will be able to sort plastic, glass, and metals (both magnetic and non-magnetic) and place them into their predetermined receptacle. The destination that the objects will be placed in is determined using multiple sensors that relay a 0 or 1 back to the PLC. This will all be done using a ControlLogix PLC and be visually displayed on a Human Machine Interface (HMI). The HMI will allow the user to Start, Stop, and Reset the system as well as show the number of objects that have been placed in each bin.

**#54 – H-BRIDGE INVERTER WITH PHASE, VOLTAGE, AND FREQUENCY MATCHING.** Joshua Henderson, Aaron Dalton and Peter Teudan. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua.

H-Bridge inverters are utilized most commonly in motor driver circuits and sometimes in the application of robots. The team researched the basic design of an H-Bridge inverter and expanded upon it to allow for voltage, phase, and frequency matching when compared to that of the 120VAC mains. This in turn allowed for a practical and cost effective approach to possibly allow a person to sell power back into the grid. While the project itself is far from this possibility, its' main goal was to come as close as possible to producing a 120VAC, 60Hz, in-phase sine wave that would essentially match what the grid was outputting. The team approached this utilizing multiple Arduino's, gate driver circuitry, zero crossing detector circuitry, a voltage regulator circuit, and a filtering circuit. When fully integrated, the zero crossing detector will be able to take the filtered signal and the grid's signal and perform arithmetic operations. These operations would delay or hold the pulsing of the gate drivers allowing for phase matching, thus tying the generated sine wave to that of the mains.

### **#55- MEGA WIMP-51 PROCESSOR CONSTRUCTION**

Ethan Hill, Scott Kirsch, Jeffrey Mason, Patrick Toplikar, Dustin Whittaker. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua.

The 8051 is an 8-bit processor that was created by Intel Corporation in 1981. Since then, many other variants have been made. The WIMP-51 is a simplified variant of the 8051 that was created at Missouri University of Science and Technology in a hardware descriptive language. Our goal is to construct a physical WIMP-51 variant of Intel's 8051 microprocessor with a reduced instruction set as an educational tool. Originally designed as a educational tool, the WIMP-51 processor takes thirteen of the fundamental instructions from the 8051. Our design reduces the architecture of the WIMP-51 into a real-time operable device constructed out of basic integrated circuits, components, and transistors in order to create an interactive educational tool to help demonstrate to the general public how a microprocessor works. The project allows students and users to see the physical parts that allow a processor to function. Users can enter instructions and control the speed the processor to see instructions get implemented one-by-one.

### **#56 - AN INTRODUCTION TO THE CAPABILITIES OF PROGRAMMABLE LOGIC CONTROLLERS.** Jared Golden, Michael Ridenhour. Electrical Engineering. Faculty Advisor: Dr. Rohit Dua.

Many automated processes currently rely on sorting to complete the objective. For example, sorting could be based on the size and color of the object. It is standard to use Programmable Logic Controllers to complete this process in the industry, as there is a wide variety of these machines to fit any size process. To show a small scale demonstration of this process, a plastic disk sorter was created that sorted disks into the correct bin based off of their size and colors. With this demonstration, the physical components could be seen, as well as the wiring required for the components. Also the graphical interface to control the system was created to simulate an interface for an operator. After creating this process a manual was created in order to document the correct operation of the system, wiring of the system, and how the system was created. Using this smaller demonstration, those unfamiliar with Programmable Logic Controllers can start to understand how this could be used on a much larger scale.

### **#57 - DECONSTRUCTED SWITCH MODE POWER SUPPLY AND LM7805,** Joshua Foster, William Cox, Colton Coffey. Engineering. Faculty Advisor: Dr. Rohit Dua.

Switch Mode Power Supplies have changed rapidly over the last few decades. The switching frequencies of the switch mode power supply can range anywhere from 10kHz to more than several mega-Hertz. As the switching frequency became faster, the complexity of the switch mode power supply became greater. This deconstructed version of a switch mode power supply allows us to demonstrate how it is operating by separating it into its more basic components. The LM7805 is a voltage regulator that has an input range from 7V to 25V and outputs a range of 4.8V to 5.2V. This deconstructed regulator will allow us to explain the importance of BJT's and their properties.

**#84 – COMPARING THE EFFECT OF DEPTHS OF DUAL-MEDIA GRAVITY FILTERS ON WATER CLARITY AND FLOWRATES.** Erin Bereyso, Nicholas Thorsen, Cooperative Engineering, Faculty Adviser: Dr. Sanjay Tewari.

The purpose of this preliminary study is to explore variation in water clarity and flow rates of dual-media gravity filters with a variation in total depths of the filtering medium. These filters are composed of up to two layers varying thicknesses consisting of sand particles separated by physical sieving. The particle sizes are 1.18mm for the large particles and 0.3mm for the small particles. The study consists of two sets of five filters having various layers of these particles - 100% large particles, 75% large particles with 25% small particles, 50% of each, 25% large and 75% small, and 100% small particles. Each set of filters had 10 inches and 5 inches of combined height of the filtering medium. Titration tubes were used as containers for the filtering medium. The volume of the sample water used for each filter was 30 ml. The initial average turbidity of the dirty water samples was 713 NTU. The percent removal of turbidity ranged from 77% to 97%. The flow rate varied from 0.05 to 0.46 ml/s/cm<sup>2</sup> for first set of experiments with total depth of 10 inches for the filtering medium. This information could be used to design an optimum gravity filter.

**#58 - U-PB GEOCHRONOLOGY AND PETROLOGY OF OLIGOCENE AND MIOCENE RHYOLITE TUFFS FROM THE NORTHERN MOGOLLON-DATIL VOLCANIC FIELD.** Mary Humphreys, Gary Michelfelder and Brooke E. Benz. Geography, Geology, and Planning. Faculty Advisor: Dr. Gary Michelfelder

The Mogollon-Datil volcanic field (MDVF) of Southern New Mexico erupted over 30 tuff units related to at least 15 caldera-forming volcanic centers. Most of these tuffs are difficult to distinguish in the field. This study looks to increase the understanding of the whole rock geochemistry and age of the volcanic tuffs in the Water Canyon quadrangle near Socorro, NM. The tuffs included in this study are the La Jencia, Vick's Peak, the Turkey Spring tuff, South Canyon tuff, Box Canyon tuff, Bell Top Tuff, and the Hell's Mesa Tuff. The La Jencia, Vick's Peak, and Turkey Springs tuffs are all phenocryst-poor. While the South Canyon Tuff is more phenocryst-rich. Zircons were analyzed with laser ablation ICPMS for U-Pb geochronology to determine the magmatic age of five of the tuffs. Petrographic thin sections were made for all of the samples in order to determine crystallinity. Whole rock samples were analyzed by XRF and ICPMS for major and trace element composition and variation within each tuff.

**#59 - URANIUM-LEAD IN ZIRCON AGE DATE ANALYSIS OF SALMON RIVER ASH TUFFS, IDAHO.** Tessa Mills, Geography, Geology and Planning. Faculty Advisor: Dr. Matthew McKay

The Cascade Volcanoes of the Western United States were formed due to the collision of smaller tectonic plates such as the Juan de Fuca, Explorer, and Gorda Plates subducting underneath the North American Plate starting in the Mesozoic leading to the area consisting of mainly metamorphic rocks. The associated volcanoes erupted pyroclastic debris that can be found in the North Western United States, including Western Idaho. These ashes are exposed along the Salmon River, located in the Riggins quadrangle, and the Rapid River located in the Heaven's Gate quadrangle, as well as exposed in road cuts along roads leading to the Heaven's Gate Fire lookout. Six samples were collected from this area. Age estimates of the ash tuffs will be concluded from U-Pb geochronology from zircon grains removed from the samples.

Determination of the age of zircon formation will help to estimate the time frame of the eruption the grain originated from. We hypothesize that the data will correlate to previously known eruptions of volcanos from the Cascade Arc and will help us attribute the ashes to a specific volcano.

**#60 - PLEISTOCENE CORALS OFF THE SOUTHWEST COAST OF JAMAICA.** Mikala Garnier. Geography, Geology and Planning. Faculty Advisor: Dr. Kevin Evans.

Jamaica has a fascinating geologic history that includes volcanic eruptions, intrusions, carbonate bank development, and subsequent rifting and uplift with later structural deformation (folding and faulting), and ultimately Holocene debris flows. The Southwest coast, near Treasure Beach, exposes carbonate rocks known as the Coastal Group. These rocks are Pleistocene in age; corals from these shoreline exposures are comparable with many modern-day corals. The goal of this research is to catalog these coral fossils using identification resources to get an idea of the corals that were in the area some 85,000 – 100,000 years ago. Many images were taken from this trip to Jamaica. Most modern corals are from the order Scleractinia. Scleractinia are stony corals usually found fossilized as aragonite or were altered to calcite. They belong to the phylum Cnidaria which are the type of corals that build their own skeleton. Corals are fascinating creatures that have been in our oceans for millions of years, and they provide helpful insight into the paleoclimate of the last interglacial stage when global sea-level was minimally 6 m higher.

**#61 - MAPPING A FLANK-MARGIN CAVE, BELMONT POINT, SOUTHWESTERN JAMAICA.** Sarah Hudson. Geography, Geology and Planning. Faculty Advisor: Dr. Kevin Evans.

Flank-margin caves form in the mixing zone, where fresh and salt water combine, resulting in dissolution of calcium carbonate. Ceiling rock can collapse, resulting in an enlargement of the cave. These processes are consistent with the development of caves at Belmont Point. The caves formed in a breccia of the mid-Eocene to mid-Miocene White Limestone Group. The objective of this project was to map one of the larger caves. Four natural entrances are found in the it. The largest is ~2.1 m in height and ~2.0 m wide. The cave widens inside. Four smaller entrances branch out from the interior, one to the east and two to the north. The northern entrance is longest, extending up to 15 m length, but the ceiling was low and did not allow us access to map further. The most expansive portion of the cave is near the center, ~5.5 meters m wide and 2 m high. From the back wall of the cave to largest entrance is ~10 m, sloping toward the back. A modern wave-cut notch is present around the sea cliff and cave exposure. This indicates that this cave has been forming for a long time and is actively eroding today.

**#62 - CLAST COUNTING IN BRECCIAS ASSOCIATED WITH A FLANK-MARGIN CAVE, SOUTHWESTERN JAMAICA.** Hannah Eades. Geography, Geology and Planning.

Faculty Advisor: Dr. Kevin Evans.

Breccias of the White Limestone Group (mid-Eocene to mid-Miocene) crop out at Belmont Point in Bluefields Bay, Westmoreland, Jamaica. Breccias form a series of sea cliffs and are extensively karstified and partly eroded by wave activity. The breccia is poorly sorted, consisting of angular clasts mostly coarser than 2 – 30 cm, and rare fossils. Breccias can be deposited as debris-flow deposition, or form as fault breccias or solution-collapse breccias. This breccia is characterized by having clasts are of the same composition as the rock unit that forms the matrix. This stands in contrast breccias that have a variety of different clasts because they were carried from a source outside of their depositional environment. The question proposed here was how this breccia was deposited, or accumulated, and if we can accurately determine if it was intraformational? The principal method of investigation included a technique to get an approximation of average and modal grain sizes. Five images of clasts were taken using a 50-cm frame. After analyzing the images, it was concluded that the clasts were supporting each other with little matrix. The low percentage of matrix is an indicator that this is solution-collapse rather than debris-flow breccia.

**#63 - BRINGING FOSSILS TO LIFE: THREE DIMENSIONAL FOSSIL IMAGING.** Mo Holley. Geography, Geology and Planning. Faculty Advisors: Damon Bassett and Dr. Toby Dogwiler

Teaching science courses online poses unique difficulties. The hands-on experience necessary for students to learn the concepts presented in lecture is presented in a laboratory setting. However, most students who are interested in taking online courses are unable to take a seated lab section. Missouri State University has two courses that require students to look at fossils, one of which does not possess a lab. Creating three dimensional models of these fossils are the first step in creating a database that would allow students to further their learning in these courses. The creation of digital catalogs of fossils would permit the development of online sections of these courses, as well as serving as an invaluable resource to students in the traditional courses. This research project aims to establish a step-by-step method for generating large quantities of 3-D images of samples within the MSU paleontological collection. Individual images and the 3-D model are stored in a database. Students will be able to access files in order to better understand the taxonomic groups that are being discussed in lecture. The collection will also generate digital backups of fossils, should they ever be lost or damaged.

**#64 - DETERMINING THE EFFECT OF GCP QUANTITY ON DEM ACCURACY IN SUAS-BASED STRUCTURE-FROM-MOTION PHOTOGRAMMETRY.** Bailey D. Pfitzner. Geography, Geology, and Planning. Faculty advisor: Dr. Toby Dogwiler.

Using small Unmanned Aerial Systems (sUAS) in combination with structure from motion photogrammetry (SfM) is an important tool. SfM allows rapid acquisition of the data required to create orthophotos and digital elevation models (DEMs) for small field areas. SfM techniques, in combination with the ability to systematically acquire the requisite sUAS imagery, is an emerging discipline and many questions remain open regarding the effect of methodological techniques on the quality and accuracy of the resulting DEMs. This study focuses on assessing the relationship between DEM accuracy and the number of Ground Control Points (GCPs) used to georeference the imagery. We deployed 26 GCPs over a 0.60 ha field site. We used centimeter accuracy RTK GPS to locate the GCPs. A flight mission with 80% side and forward image overlap at an altitude of 35 m above ground level was flown with a DJI Phantom 4 Professional sUAS with a 20 megapixel camera capturing orthogonal images. The SfM processing was completed with Agisoft Photoscan (v. 1.4). The resulting DEMs were exported to ArcMap version 10.5 for analysis.

**#65 - A REUNIFIED DIVISION: THE CITY OF BERLIN,** Zak Baldwin. Geography, Geology, and Planning. Faculty Advisor: Dr. Krista Evans.

Berlin, Germany, is a growing world city with a rich history that is becoming an international leader in the realm of economics and foreign relations. Berlin started as a small trading post for Germanic tribes along the Spree River. The city would develop and become a beacon of prosperity in the region. Today, Berlin has reached a chapter in societal growth by hosting many immigrants from various foreign countries. As imperialism swept the country during the 19th century, Berlin would peak with industrialization and expand the economic reign it had within Europe. However, Berlin's fortune would turn as WWI and WWII resulted in significant setbacks for the city and the country of Germany. Berlin has recently been rejuvenated due to the reunification of a once divided country. The city is currently making strides towards becoming preeminent city. This progress, nevertheless, has been observed through a post-industrial lens in which exponential growth is not typically noticed. Today, the city has expanded in tourism, social culture, and is prospering economically. This research into the history and urban planning of Berlin has shown that the city is innovative and bound for a great future.

**#66 - GEOVISUALIZING JORDAN CREEK THROUGH TIME.** Michael Baird,

Geography, Geology, and Planning. Faculty Advisor: Dr. Judith Meyer.

Most cities, both ancient and modern, are located along waterways. Springfield, Missouri is no exception as settlers built the city along Jordan Creek. Over time, however, as population and industrialization increased, the creek became polluted and flooded frequently. In response, the creek was re-engineered to flow under the city. Today's stormwater management plans call for "daylighting" the Jordan Creek by constructing a new, above ground stream ecosystem as part of a greenway corridor. This project uses rephotography to create photo pairs of downtown Springfield in 1934 and 2019 as well as aerial maps over a similar time span. Analysis of the photo pairs is both qualitative and quantitative: visual comparison of the photo pairs as well as other historical photographs, interviews, and site visits and inspections. The analysis was further supported by maps and historical records. Results of this project suggest that daylighting and naturalizing Jordan Creek reduces flooding and creates a healthy ecosystem. Evidence suggest a beautiful creek along a linear greenway park, including walking and biking paths, will infuse money into the economy through tourism, recreation, and civic pride.

**#67 - ARE FISH SANCTUARIES MEETING THEIR INTENDED GOALS IN**

**JAMAICA?** Margaret Alexander, Geography, Geology and Planning. Faculty Advisor: Dr.

Robert Pavlowsky

Government fish sanctuaries are often controversial because they can limit the use of marine access to fisherman, some of whom may not easily afford the costs of moving to new fishing grounds. This study evaluates public opinions about the success of two marine conservation areas: Bluefields Bay and Galleon Harbour created in 2009 along the south coast of Jamaica. During a field visit in March 2019, I investigated the opinions of various stakeholders through social visits and on-tour discussions with wardens, founding members of the sanctuaries, fisherman, and local residents to evaluate if the sanctuaries were meeting their intended goals. Overall, people believe the fish sanctuaries are meeting planned goals for both fish and community. However, some locals are finding it harder to afford equipment and larger boats needed to reach the fishing banks located further out to sea. Sanctuaries have a significant spillover effect with increasing marine life spreading beyond the boundaries of the conservation area. However, programs to help fisherman transition from near to off-shore fishing grounds could be implemented to offset the financial hardship created by a no-take conservation area. Better integration of sanctuary use with sustainable tourism businesses can expand the economic benefits to the community.

**#68 - CONSERVATION AND RESTORATION OF JAMAICAN CORAL REEFS.** Krista

Busick, Geography, Geology and Planning. Faculty Advisor: Dr. Robert Pavlowsky

The Caribbean Sea has been facing a major loss of coral reefs for many years, due to pollution, natural disasters, eutrophication, as well as over fishing. My research focused on a few localized areas around the Jamaican coast which includes Bluefield's Bay Fish Sanctuary. Coral reefs are important because they are the support system of the sea. They are some of the most diverse and valuable ecosystems on Earth. Coral Reefs buffer shorelines from wave action and prevent erosion, property damage and loss of life, as well as nutrient recycling, and carbon and nitrogen fixing. This source of nitrogen and other nutrients are essential in marine life food chain. The purpose of my study was to find out what the major loss of corals are in the Caribbean, and what is being done to repair the damages and make up for the loss of the reefs. Current methods of restoration include nursery's, they are protected areas along the coast that allow healthy corals to be regrown. There are also efforts made towards making artificial coral that still provides the same benefits as a living coral. Coral reefs are our oceans roots.

**#69 - CONSERVATION OF CORAL REEFS IN BLUEFIELD'S BAY, SOUTHWEST COAST OF JAMAICA.** Krista Busick. Geography, Geology and Planning. Faculty Advisor: Dr. Robert Pavlowsky

The Caribbean Sea has been facing a major loss of coral reefs for many years due to pollution, natural disasters, eutrophication, as well as over fishing. Jamaica's coral reefs are particularly degraded and there are concerns by international agencies about how to improve coral reef health. Coral reefs are important because they are the support system of the sea functioning as the life-giving "roots" of the coastal zone. They are some of the most diverse and valuable ecosystems on Earth. Coral Reefs buffer shorelines from wave action and prevent erosion, property damage, and loss of life. In addition, coral is important for nutrient recycling, carbon sequestration, and nitrogen fixing. This study addresses the health of coral reefs and management efforts to conserve them in Bluefield's Bay, a no-take fish sanctuary. Projects in the bay include the testing of artificial reef structures, installation of a coral nursery where young coral is grown for transplanting, and coral re-seeding. The result of these efforts will not be known for years to come, however, the attention brought to the bay about coral health has raised locals concerns for protection of the water quality and coral reefs in Bluefield's Bay.

**#70 - INFLUENCE OF CHANNEL GEOMORPHIC PROCESSES AND SEDIMENT METAL CONCENTRATIONS ON MACROINVERTEBRATE COMMUNITIES IN URBAN STREAMS IN SPRINGFIELD, MISSOURI.** Madalyn Behlke-Entwisle, Ethan Pelke, Micah Seago. Geography, Geology, and Planning. Faculty Advisor: Dr. Robert Pavlowsky.

Physical habitat assessments are often used to characterize macroinvertebrate sampling sites for stream impairment assessments. This study examines the relationship between benthic macroinvertebrate community indices (EPT & Taxa Richness) in urban streams in Springfield, Missouri, and geomorphic indicator scores. Potential effects of sediment metal toxicity will also be evaluated. Six long-term monitoring reaches approximately six channel widths long were surveyed for this study across a range index scores. A modified rapid geomorphic assessment procedure that evaluated channel processes such as incision, aggradation, widening, and planform adjustment was used to identify the degree and cause of channel instability and degraded habitat. Active stream sediment was sampled at three sites within each sampling reach, and the <250 um fraction was analyzed for metals in the laboratory using X-Ray Fluorescence (XRF). Organic matter content in the <250 um fraction was also analyzed using a Loss-on-Ignition test. Macroinvertebrate community index values were found to have a strong relationship to heavy metal content, but their relationship to geomorphic indicator scores was weaker than expected.

**#71 - HISTORY AND CULTURE OF GANJA FARMING IN JAMAICA** Justin Butkovich, Geography, Geology and Planning. History. Faculty Advisor: Dr. Robert Pavlowsky

Cannabis (Ganja) growing and use is an important economical and cultural element of Jamaican life. However, recent trends for legalization in other countries, including the USA, may threaten export opportunities. This study examines the historical geography of Ganja and its farming and exportation in Jamaica to evaluate how internal cultural norms and economic approaches may respond to external market factors. A field study in March 2019 was used to assess the common perceptions of the taboo and other cultural aspects of Ganja in St. James, St. Elizabeth, and Westmoreland parishes. Qualitative information was collected from research prior to visiting Jamaica, discussions with locals local, and observations within the communities visited. Ganja has been intertwined with Jamaican culture since it was first introduced by Indian migrants in the mid-1800s and was used by the lower class for medicinal purposes then later by Rastafari for deepening of faith. Ganja farming is increasing in Jamaica due to large corporations competing with local growers. While Ganja is not fully legalized, Jamaican society views Ganja similar to alcohol or tobacco. Ganja culture and availability drives a substantial amount of tourism in Jamaica which may decrease in the future because increased legalization worldwide in recent years.

**#72 - RASTAFARIANISM AND ITS RELATION TO MUSIC DURING WORSHIP IN JAMAICA.** Christine Newberry. Geography, Geology and Planning. Religion. Faculty Advisor: Dr. Robert Pavlowsky.

The Rastafarian religion is both a spiritual and social movement that was started during the depression of the 1930's in Kingston, Jamaica when it was still a colony of Great Britain. It was a time of racism, great poverty, depression, and class discrimination. The Rastafarian beliefs and message of hope brought redemption, freedom from oppression, and black pride. In order to connect with Jah, their single black God, Rastas hold religious ritual meetings called reasoning sessions. These sessions may involve group mediation, ritual smoking of ganja (marijuana), and traditional music called Nyabinghi. This music incorporates a blend of African drumming and 19<sup>th</sup> century gospel music. Nyabinghi uses three drums: the fundeh, peta, and bass. It is believed that these drum sounds carry the divine energy of Jah. Nyabinghi music uses chanting, drums, and singing to help Rastas reach a state of heightened spirituality and enhanced feelings of unity among other Rastas and the world they live in. Nyabinghi became associated with reggae music due to the fame of Bob Marley and the Wailers in the 1960's. Their lyrics included messages about oppression, slavery, poverty, and human rights. The popularity of reggae music became the vehicle in which Rastafarianism was spread worldwide.

**#73- COMPARING REASONS TO VISIT MARDI GRAS IN NEW ORLEANS BETWEEN PEOPLE WHO HAVE ATTENDED AND THOSE WHO HAVE NOT**

Kennedy Powell, Blake Woods, Darby Graham, Chris Cox, Jin Chang, Huan Ma. Hospitality Leadership. Faculty Advisor: Yoshimasa "Nancy" Kageyama.

The city of New Orleans is home to one of the largest Mardi Gras festivals in the world and every year brings thousands of tourists to the city. The festival includes parties, great food, and a wealth of culture for about a month. In this study we will be discovering the biggest reason that travelers travel to New Orleans for Mardi Gras. We will be asking people of different ages if they would like to go to this festival and then asking for their reasons for why or why not. We will use this information to compare the biggest draws to the festival and also what are the drawbacks that prevent some visitors from traveling there. Also in this study we will be asking people that have previously been to Mardi Gras what was their favorite part and what would make them want to return, or not. With this collection of information we will be able to compare what people think they will enjoy the most about Mardi Gras to what to end up enjoying the most.

**#74 - BASIC NEURAL NETWORKS AND IMPLEMENTATION** Yutang Li. Mathematics. Faculty Advisor: Dr. Songfeng Zheng

Artificial neural networks, inspired by the studies in biological neurons, are one of the major tools used in machine learning. With decades of investigations by mathematicians, computer scientists, and engineers, artificial neural networks have been widely used in various technology fields. This study investigates the basic architecture and training process of a typical artificial neural network (ANN) and convolutional neural network (CNN), a recent development in this area. We built a neural network from scratch to accomplish a hand-written digits recognition task, and compared the results of ANN and CNN to those from open-source machine learning tools.

**#75- THE NATURE OF TEACHER QUESTIONING AND RESPONSES TO STUDENT QUESTIONS IN THE MATHEMATICS CLASSROOM** Frannie Haller, Secondary Mathematics Education. Faculty Advisor: Dr. Patrick Sullivan.

For many years, novice teachers have been taught that asking their students questions is the best method for communicating information, responding to student questions, and enhancing student learning. However, instead of questioning the student's conceptual understanding of the problem, advancing their knowledge of the material, many teachers simply ask how the student got their answer and the procedural steps they took to solve the given problem. Teachers should pose purposeful questions to students with an intent to advance the student's conceptual understandings in order to direct their mathematical thinking in a forward motion. These questions and teacher responses are given to students to lead their minds down a new path, guiding them into a struggle with the material where they end up victorious in understanding the concept deeper than they did before. To discover the nature of teacher questions and responses, we used videos of mathematics classrooms, collected for a professional development experience using a SWIVL robot and iPad. With this, we found that the most impactful dialogue with students occurs when teachers ask advancing questions and listen to what their students are saying followed by a pivotal response, directing the student's thinking in a new mathematical direction.

**#76- COLORABILITY OF SURFACES.** Austin Beard, Mathematics. Faculty Advisor: Dr. Mark Rogers.

The colorability problem asks how many colors are needed to color a map so that adjacent regions are colored with different colors. We used tools from combinatorial topology such as homology groups and the Euler characteristic to examine different aspects of colorability, such as The Four Color Theorem, Heawood's Conjecture, and colorability of a map on a sphere, torus, and Moebius strip.

**#77 - COLORING KNOTS WITH QUANDLES.** Gabriel Wallace, Mathematics. Faculty Advisor: Dr. Mark Rogers.

Knot theory is a relatively new field of mathematics studying objects inspired by real life knots in ropes and shoelaces. A naive approach to studying knot theory is by drawing many pictures and creating models of knots, but this is inefficient. We can use quandles, an algebraic structure, to help translate knots into the language of algebra. To tell one knot from another, knot theorists develop different knot invariants, and one of the most intuitive invariants to understand is coloring the strands of a knot. In this presentation, we present different ways to color a knot. We begin with the naive and straightforward approach and then develop more advanced techniques using quandle theory.

**#78 - A PROBLEM INVOLVING DIGITAL SUMS.** Vincent Blevins, Mathematics. Faculty Advisor: Dr. Les Reid.

In the November 2018 issue of *Crux Mathematicorum*, this problem was posed: “Find all natural number  $n$  satisfying the following property: for every integer  $k \geq n$  there is a multiple of  $n$  whose digits add up to  $k$ .” It is fairly easy to see that if  $n = 2^a 5^b$ , then  $n$  has the desired property. It is also fairly easy to see that if  $n$  is a multiple of 3, then  $n$  does not have the desired property. Here is another example: if  $n = 11$ , then 209 is a multiple of 11 with a digital sum of 11, 66 is a multiple of 11 with a digital sum of 12, 11209 is a multiple of 11 with a digital sum of 13, 1166 is a multiple of 11 with a digital sum of 14, 1111209 is a multiple of 11 with a digital sum of 15, etc., so 11 has the desired property. Numerous computer calculations indicate that any  $n$  that is not a multiple of 3 has the desired property. The author will present his progress toward the resolution of this conjecture.

**#79 - MODELING ATOMIC LAYER DEPOSITION OF ALUMINA AS AN ULTRA-THIN TUNNEL BARRIER.** Devon Romine, Devon T, Daniel J. Fishbien. Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Ridwan Sakidja

This reactive molecular dynamics (MD) study is trying to model the Atomic Layer Deposition (ALD) process to form an ultra-thin tunnel barrier made of alumina and magnesium. We will evaluate systematic role of the precursors, like trimethylaluminum (TMA) and Bis(2-ethyl-1,3-cyclopentadien-1-yl)magnesium ( $C_{14}H_{18}Mg$ ), and water pulse toward the chemical reactions that take place on the surface. We will then evaluate the role of temperature for the internal structure of the amorphous alumina/magnesium as the final deposition product. We will also evaluate the difference between the two barriers made from the different precursors. The support of NSF (Grant No. 1809284) from the Electronics, Photonics and Magnetic Devices (EPMD) Program is gratefully acknowledged.

**#80 - MOLECULAR DYNAMIC SIMULATIONS OF METALLIC SYSTEMS.** Austin Bollinger, Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Ridwan Sakidja

This project studies the effects of compression on the mechanical deformation of metallic systems, specifically made of Nickel-based alloys for advanced power plants. The study of compression mechanics can be applied to many fields of metallurgy and materials science, and in this case in the application of mechanical modeling to elucidate how these deformation mechanisms will affect polycrystalline systems. By employing the molecular dynamics simulation, the roles of thermodynamics, compression rate, and sample size can be carefully evaluated to optimize the strength of the materials under high temperature operating conditions. The support from NETL (DOE) Grant No. FE0031554 is gratefully acknowledged.

### **#81 - DEVELOPMENT OF EMBEDDED ATOMIC METHOD (EAM) MOLECULAR DYNAMICS (MD) TRANSITION METAL CARBIDE POTENTIALS.**

Tyler McGilvry-James, Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Ridwan Sakidja.

We are developing a series of transferable Embedded-Atom Method (EAM) interatomic potentials for molecular dynamic simulations. These potentials are designed to model the physical properties of intermetallic carbides in the form of  $M_{23}C_6$ , where M is a transition metal. Here we consider M to be the transition metals of Chromium (Cr), Tungsten (W), and Molybdenum (Mo). Isothermal-isobaric (NPT) and isothermal-isochoric (NVT) ensembles are used to stabilize the supercell and collect the input data. We employed the MEAMFIT code that utilizes the force, stress, and energy matching procedures to parameterize the EAM potentials. We further then used the potentials for various phases of these materials to verify for their thermal stability at temperatures ranging up to 2000K. Supports from NETL (DOE) Support under the FE0031554 Grant are gratefully appreciated.

### **#82 - MOLECULAR DYNAMICS SIMULATIONS OF A HYDROUS ANDALUSITE MELT.**

Weston R. Renfrow, Physics, Astronomy & Materials Science. Faculty Advisor: Dr. Robert A. Mayanovic.

Water dissolution in silicate melts has a direct affect on magmatic processes and mass transport occurring within the Earth's crust. By studying how water dissolves in a silicate melt and modifies its structural and physical properties, we can gain a better understanding of the volcanic, tectonic and water cycle processes of the Earth and, potentially, that of exoplanets. Currently there are no studies on hydrous (i.e., with soluble water) silicate melts with sufficient data on the structure of such systems. The reason for this is because of the formidable hurdles that need to be overcome to make such studies experimentally. However, computational studies of hydrous silicate melts are within grasp. Andalusite is a nesosilicate having the chemical formula  $Al_2SiO_5$ . Molecular dynamics (MD) simulations are performed on large-scale computational cells containing slabs of andalusite melt that is initially surrounded by water molecules. ReaxFF force fields are utilized to realistically model the chemical reactions between the andalusite melt and water molecules, hydroxide and hydrogen species. The results from the MD simulations that are used to make a quantitative structural analysis of the hydrous andalusite melt will be discussed.

### **#83 - MOLECULAR DYNAMICS SIMULATIONS OF THE ANORTHITE-WATER MELT SYSTEM.**

Devon T. Romine and Robert A. Mayanovic, Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Robert A. Mayanovic

Water dissolution plays an important role in modifying the physical properties of silicate melts. This can manifest in the increase of eruptive power of magmas and in more effective transport of specific elements in magmatic processes. The studies from this project have the potential to ultimately gain a better understanding of the water cycle and plate tectonics of the Earth. The results from modeling studies of hydrous silicate melts also have the potential to constrain habitable zones of exoplanets. Anorthite is the Ca end member of the plagioclase series with a chemical formula  $CaAl_2Si_2O_8$ . Relatively large simulation-cell molecular dynamic (MD) calculations have been made on the water-anorthite system in order to make a quantitative structural analysis of the system. ReaxFF force field potentials are used in order to simulate the chemical reactions that are known to take place in natural systems. Our MD simulations show extensive diffusion of water into the anorthite melt after sufficient equilibration of the system, leading to protonation and deprotonation reactions. These ultimately result in depolymerization of the hydrous anorthite melt and formation of Si-OH and Al-OH bonds.

## **#85 - SYNTHESIS OF PbO<sub>2</sub> THIN FILMS FOR PEROVSKITE CH<sub>3</sub>PBX<sub>3</sub> BASED**

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A highly compact electron-selective Pb-based perovskite solar cell active layer is cost effective, easy to fabricate, enhances the efficiency of the cell by promoting electron mobility, and reduces recombination effects. PbO<sub>2</sub> compact thin films were developed on a soda-lime glass substrate and investigated for application as a perovskite solar cell. Anatase crystalline phase is preferred due to its large band gap. The film was made via pulse laser deposition (PLD) using a Pb target with an oxygen atmosphere. 10,000 shots were applied at an atmospheric pressure of 10<sup>-3</sup> mbar with a laser fluency of 4.2  $\frac{mJ}{s^2}$  and substrate temperature of 300 K. Sample structure and composition were characterized using X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Electron Dispersive X-Ray Spectroscopy (EDS), and Raman Spectroscopy. Post EDS results indicated excess oxygen bonding with the Pb film resulting in phases of PbO<sub>3</sub> and Pb<sub>3</sub>O<sub>4</sub> among others. This work focuses on the analysis of oxygen reduction related to the stoichiometric ratio of our film by varying atmospheric conditions and the different annealing conditions of the PbO<sub>2</sub> compact layer on the solar cell substrates.