**#1 - NEOTROPICAL BIRD POPULATION ASSESSMENT AT BULL SHOALS FIELD STATION.** Baillie Shebesta, Biology. Faculty Advisor: Dr. Janice Greene.
Neotropical migratory bird species spend their winters in Central and South America. They then migrate to North America in the spring and summer to breed and raise their offspring. Neotropical birds are sensitive to ecological and environmental disturbances and changes. Monitoring their populations allows biologists to assess the overall health of the environment. Birds were caught in mist nests at the Bull Shoals Field Station. Researchers recorded data for individual birds including species, age, sex, wing length, weight, date, time of capture, and each bird was given a leg band. This study analyzed data from May through August 2010-2015. Analysis of the data revealed some basic patterns such as the Eastern Tufted Titmouse is the most common species caught; birds were most active during the morning; and most birds were caught in June and July. There was a fair amount of recaptures, which means that birds are returning to the area, and their preference for this habitat is an indication that it is strong and healthy.

**#2 – METABOLICALLY ENGINEERED *GLUCONOBACTER OXYDANS* FOR THE PRODUCTION OF OPTICALLY PURE ACETOIN: A PHARMACEUTICAL PRECURSOR.** Neil Bolduc, Biology. Faculty Advisor: Dr. Paul Schweiger.
*Gluconobacter oxydans* belongs to a distinct group of acetic acid bacteria known for their unique ability to incompletely oxidize substrates under normal growth conditions, releasing products into the medium. This feature is biotechnologically relevant as the incompletely oxidized products are often stereo- and regio-selective. This unique metabolism is dependent on membrane-bound dehydrogenases that channel electrons from substrates into the respiratory chain. These dehydrogenases are natural biocatalysts that simplify the production and recovery of enantiopure chemicals, which normally require expensive and troublesome organic chemistry to produce, providing a route to sustainable green chemical biomanufacturing. One aim is to metabolically engineer *G. oxydans* for the production of enantiopure acetoin. Acetoin was designated a top 30 platform chemical by the US DOE and is used to produce pharmaceuticals, cosmetics, food flavorings, and liquid composites. Two *G. oxydans* enzymes are predicted to be important for acetoin production: 1) a known PQQ-dependent polyol dehydrogenase (SldBA), and 2) an uncharacterized FAD-dependent sorbitol dehydrogenase (mSDH). To rationally design *G. oxydans* for enantiopure acetoin production we are investigating the role of mSDH in biomanufacturing by analyzing deletion mutants and expression strains. This information will be used to produce strains for improved sustainable green chemical biomanufacturing of enantiopure acetoin.

**#3 – IMPROVING INFLAMMATION IN BACTERIAL COINFECTION BY IL-1β REGULATION.** Angeline Rodriguez and Abbi Mabary, Biology. Faculty Advisor: Dr. Christopher Lupfer.
Viral bacterial coinfections have been known to cause severe reactions in the elderly and in pediatric patients. Antibiotics like β-Lactams kill the bacteria, yet cause inflammation in the process. Interlukine-1β (IL-1β) is an important immune signaling molecule responsible for inflammation. It exists as an inactive precursor that can be activated by Caspase-1 containing inflammasomes (multi-protein complex). Influenza A virus and *Streptococcus pneumoniae* activate the inflammasome through the NOD-like receptor protein NLRP3. Previous reports indicate that IL-1β levels are dramatically elevated during coinfection with Influenza A virus and *Streptococcus pneumoniae*. However, how IL-1β levels increase and their importance in coinfection is not known. We have discovered that IL-1β expression and secretion is increased during coinfection as a result of activation of multiple signaling pathways simultaneously. This was concluded in preliminary experiments where macrophages deficient in the Myd88-/-, Tlr2-/- or Nlrp3-/- genes were examined for their effects on IL-1β augmentation.

**#4 – GENERATION OF YEAST 2-HYBRID CLONES TO EXAMINE THE ROLE OF NUCLEOTIDE OLIGOMERIZATION AND BINDING DOMAIN (NOD)-LIKE RECEPTORS.** Abbi Mabary and Angeline Rodriguez, Biology. Faculty Advisor: Dr. Christopher Lupfer.

NOD-like receptors (NLRs) are a class of cytoplasmic proteins essential for the initiation and regulation of immune responses to infectious disease, metabolic and cellular damage and cancer. The human genome encodes for 22 NLR proteins. However, only about half of the 22 NLRs have known functions, and the mechanisms by which they function are even more ambiguous. Previous research indicates that some NLRs, like NLRP3, have the ability to activate Caspase-1 and form the "Inflammasome," which is a multiprotein complex responsible for cleaving the potent inflammatory cytokine interleukine-1β (IL-1β). Another NLR, NLRP12, functions as a regulator of inflammation, thus serving as a negative feedback mechanism. Although the general function of these two proteins is known, how they are activated is not known. We are, therefore, embarking on a journey to find novel proteins that interact with NLRP3 and NLRP12 in an effort to decipher the mechanisms by which they function. We are generating a yeast 2-hybrid system to examine the interaction of NLRP3 and NLRP12 with a human cDNA library. Novel interactions discovered through this 2-hybrid screen should provide novel insight into the function of these NLR proteins and help us understand the immune response to infectious and non-infectious diseases.

**#5 - COMPARING CLIMATE PATTERNS AND POPULATION ESTIMATES OF WHITE-TAILED DEER IN REGIONAL NATIONAL PARKS.** Kyle Doherty, Biology. Faculty Advisor: Dr. Sean P. Maher with David G. Petz (National Park Service)

White-tailed Deer (*Odocoileus virginianus*) are one of the most common cervids in North America and the most widely hunted big game species in the United States. Understanding *O. virginiaus* dynamics is crucial to management, particularly how disease and vegetation patterns could negatively impact population growth. Since 2004, the National Park Service (NPS) has completed evening spotlight surveys at 3 parks, Wilson's Creek National Battlefield, Pea Ridge National Military Park, and Arkansas Post National Memorial. Using these data, we modeled abundance of deer using distance models with the distance package in R, and compared these estimates to previously reported values. To explain population fluctuations, we used local climate data and compared the amount of variation explained by certain climate factors. We found that our abundance estimates were consistent with those obtained by NPS, including extreme variation in population sizes of less than 20 to over 400 for each parks. Climate variables were able to explain some of the variation, but the identity of the best-supported model differed among parks, suggesting different mechanisms are affecting these populations. By comparing population fluctuations and climate patterns, more insight can be gained when assessing past management decisions and planning future management changes.

**#6 – PROJECTED DISTRIBUTION OF FRANKLIN'S GROUND SQUIRREL (POLIOCITELLUS FRANKLINII) UNDER POTENTIAL FUTURE CLIMATE CONDITIONS**. Benjamin Spitz, Biology. Faculty Advisor: Dr. Sean P. Maher

Global anthropogenic change has and will continue to impact many organisms, especially habitat specialists within a fragmented landscape. Franklin's ground squirrel (*Poliocitellus franklinii*) is a prairie species that occurs in the Midwestern United States and its range extends north into Canada. Currently prairies are becoming widely developed greatly reducing *P. franklinii* habitat of shrubs and tall grasses in and around edges causing them to become species of concern. In Missouri, this is a species of special concern due to reduced habitat in the state. Using a set of data capture points and models of current climate, we created ecological niche models for *P. franklii* using MaxEnt. We then projected the models onto future climate scenarios representing increasing amounts of carbon emissions, and summarized the potential distribution of *P. franklli* under novel conditions. Currently, *P. franklii* is expected to have a limited distribution in Missouri and could be extirpated from the state by the end of the 21$^{st}$ century. Beyond Missouri, areas of suitable climate will become more sparse and fragmented across the distribution of the species.

**#7 – THE EFFECT OF BLOOD FLOW ON VASCULAR SMOOTH MUSCLE CELL COVERAGE OF EMBRYONIC BLOOD VESSELS.** Shilpa Mohite, Biology. Faculty Advisor, Dr. Ryan Udan

During embryonic development, blood vessels are formed (from endothelial cells) by a process called vasculogenesis. These early vessels remodel to form a hierarchy during angiogenesis—creating large-diameter arteries that branch into small-diameter capillaries. The vessels respond to growth factors, which act to cover the vessels with an outer tissue layer of vascular smooth muscle cells (vSMCs) in a process called maturation. **What remains unclear is why arteries have a thicker vSMC layer than capillaries**. Since previous studies have implicated that mechanical forces provided by blood flow control the formation of arteries over capillaries, we hypothesize that blood flow may also determine the extent of vSMC coverage. We compared the extent of vSMC coverage in vessels from normal-flow embryos to reduced-flow embryo vessels. We observed less vSMC coverage around both extraembryonic and intraembryonic arteries in the reduced-flow embryos. To determine how flow could promote changes in vSMC coverage, we investigated changes in Notch and MMP9 signaling. Our qRT-PCR data showed that Hey1 was downregulated while MMP9 was upregulated in reduced flow vessels. This suggests that Notch is activated by high flow to increase vSMC coverage of arteries while MMP9 might be involved in the migration of the vSMCs.

**#63 - QUANTIFYING VASCULAR SMOOTH MUSCLE CELLS IN MOUSE EMBRYONIC YOLK SACS UPON REDUCTION OF HEMODYNAMIC FORCE.** Tanner Hoog, Rachel Padget, and Shilpa Mohite. Research Advisor: Dr. Ryan Udan

Vasculogenesis and angiogenesis are the mechanisms by which blood vessels create a hierarchy that is grown throughout the body. Hemodynamic force (the force that the blood stream exerts onto vessel walls as it pumps through the vasculature) has previously been shown to play a role in determining this blood vessel hierarchy. We hypothesize that hemodynamic force also plays a role in the recruitment of vascular smooth muscle cells (vSMCs) to blood vessels. By utilizing a confocal microscope, we can observe qualitative changes in blood vessel morphology in developing mice embryos--where the number of vSMCs appear to decrease upon reduction of hemodynamic force (using reduced-flow mutant mouse embryos: Myl7-/-) as compared to control samples (using normal-flow mouse embryos: Myl7 +/+). To quantify this data, we will perform flow cytometry and immunostaining to compare the number of vSMCs in E10.5 reduced flow mutant mice as compared to controls. Should these results verify our hypothesis, we expect to see a reduced percentage of vSMCs in the mutant embryos as compared to the controls.

**#8 – SUBCELLULAR LOCALIZATION AND FUNCTION OF TRUNCATED VPS1 INFORMS PHYSIOLOGICAL SIGNIFICANCE OF DYNAMIN-LIKE PROTEINS.** John Short, Biology. Faculty Advisor: Kyoungtae Kim.

Yeast protein Vps1, homolog of human protein dynamin, is required for proper vacuolar formation and protein sorting. In humans, dynamin defects cause protein missorting leading to Alzheimer's disease, centronuclear myopathy, and Charcot-Marie-Tooth disease. In yeast, Vps1 defects also cause missorting of proteins resulting in abnormal phenotypes. Vps1 has been shown to interact with and target to lipids of the cell membrane and organelles like the Golgi body and endosome, but the mechanism of targeting has not been determined. To investigate which part of Vps1 facilitates interaction, the full-length gene and its individual domains (GTPase, MID, and GED) were tagged with RFP and expressed in cells lacking endogenous VPS1. Membrane markers of endocytic sites, Golgi, and endosome were tagged with GFP, and colocalization with mRFP-Vps1 and its fragments was observed using confocal microscopy. Ability of the fragments to rescue abnormal phenotype was examined. Secretion of missorted cargo proteins outside of the cell was detected using Western Blot. The data show that MID, GED, and MID+GED fragments individually targeted to the Golgi and endosome. However, these fragments were not functional for Golgi cargo sorting or endosomal membrane recycling, suggesting that intact full-length Vps1 proteins are essential for facilitating these cellular events.

**#9 – UNDERSTANDING THE FUNCTIONAL RELATIONSHIP BETWEEN THE RETROMER COMPLEX AND VPS 1.** Mariel Delgado Cruz, Chris Trousdale, Biology. Faculty Advisor: Dr. Kyoungtae Kim

Membrane trafficking is the process by which cells excrete waste and other elements as well as ingest extracellular substances in order to maintain homeostasis. Specifically, retrograde trafficking follows the movement from the endosome to the Golgi complex. When retrograde transport is disturbed, it has been shown to associate with diseases such as Alzheimer's, Parkinson's, Huntington's and Amyotrophic Lateral Sclerosis. In yeast, retrograde transport is aided by the Retromer, a multi-subunit protein complex which coats the endosome. Here, we present the functional relationship with the Retromer complex and Vps 1, the yeast homologue to mammalian dynamin. Our data revealed that the Vps 1 and Retromer subunits genetically and physically interact. A particular interaction was observed between Vps 1 and Retromer subunits: Vps 5, Vps 29, and Vps 35. Future studies will look into the physiological significance of the interaction between Vps1 and Retromer in the context of retrograde trafficking.

**#10 – ONTOGENETIC DIFFERENCES IN SENSITIVITY OF HOUSE MICE INJECTED WITH COTTONMOUTH VENOM**. Sabrina Messick, Biology. Faculty advisor: Dr. Brian Greene

Snake venoms are complex mixtures of biomolecules that represent a key foraging adaptation in advanced snakes. Venom toxicity importantly influences the foraging success of venomous snakes and is thought to be under strong selection pressure. However, venom sensitivity varies both among and within prey types. We tested house mice (*Mus musculus*) for their sensitivity to cottonmouth (*Agkistrodon piscivorus*) venom to determine if age and body size of mice influenced their time to death. Venom concentrations of 5, 10, and 15 mg/mL were injected into adult and juvenile mice and revealed two important findings. The time to death of mice in both groups was negatively correlated with venom concentration. However, juvenile mice were considerably less sensitive to venom than adults. The reason for the ontogenetic differences in venom sensitivity in mice is unknown but correlate with recent findings suggesting that foraging cottonmouths compensate for venom sensitivity by injecting relatively more venom into small mice

**#11 - RESPONSES OF NEONATAL COTTONMOUTH SNAKES TO CUTANEOUS CHEMICAL CUES FROM OTHER SNAKES POSING DIFFERENT LEVELS OF PREDATORY RISK**. Alex J. Meinders, Biology. Faculty Advisor: Dr. Brian Greene.

Snakes mainly use chemical cues to detect predators and to assess the risk of predation. Many snake species are known to exhibit threat sensitivity by scaling their avoidance of different organisms based on the risk that they pose. King snakes are specialized predators of other snake species, including venomous species. We tested the threat sensitivity hypothesis in cottonmouth snakes (*Agkistrodon piscivorus*) by evaluating their responses to king snake (*Lampropeltis getula*) chemical cues and those of a non-predatory rat snake (*Pantherophis alleghaniensis*). We predicted that cottonmouths would exhibit threat sensitivity by avoiding king snake cues but not rat snake cues. The outcomes of this experiment are also predicted to be size-dependent given that small king snakes would only pose a threat to juvenile cottonmouths and not adults. The results of this experiment are currently incomplete but will be presented.

**#12 - EFFECTS OF PURE CARBON NANO TUBES ON PLANT LEAF PHYSIOLOGY AND GROWTH.** Payton Henke, Biology. Faculty Advisor: Dr. Alexander Wait

Carbon nanotubes are (CNTs) used in many products. They can be found, for example, in electronics, concrete, bio sensors, and specialty surface coatings. Because of this, CNTs will make their way into the environment (e.g., landfills) and we do not yet know the negative effects of CNTs on the environment. Most of the current research on CNT toxicity is on the cellular and tissue level. CNTs have also been shown to enhance fruit production or if inserted into chloroplasts, increase photosynthetic efficiency. I used a pure, or pristine, single walled CNT to determine the effect on *Arabidopsis thaliana* growth, gas exchange, and water relations. My research examined the effects of high concentration in a soil media on mature plants. To date, I have added roughly 1240 micrograms/mL total of CNTs to the mature plants over a three week period and I have no evidence of toxic effects. Neither leaf chlorophyll, leaf specific weight, or percent water in leaves was affected by the addition of CNTS. However, preliminary data on the effects of another engineered nanoparticle. This research paves the way for future assays on the effects of engineered nanoparticles on plant growth and development.

**#13 - EFFECT OF CARBON NANOTUBES ON INSECT GROWTH**. Ashley Prince, Biology. Faculty Advisor: Dr. Alexander Wait

Nanomaterials are used widely in technology today. As a result, they are also becoming more abundant in the environment. Carbon nanotubes (CNTs) are the most widely used. The structure of CNTs is similar to asbestos, raising questions about toxicity of CNTs. There is no literature on the effects of CNTs on insect growth and physiology. The purpose of this research is to determine if CNTs are toxic to insects. *Tenebrio molitor*, commonly known as the mealworm, was used in this experiment. *T. molitor* has four life stages: egg, larva, pupa, and adult (beetle). *T. molitor* stays in the larva stage for 8-10 weeks and molts 10-20 times (instars). The feed consisted of 60 g. of oats with 34 mL of CNTs (34 mL of D.I. water for the control group). The CNTs were purchased from Brewer Science Inc. in the form of CNTRENE™ C100LM, a solution of CNTs and D.I. water with a concentration of 0.290 mg/mL and 6.5-7.5 pH. The feed was baked at 200˚ F for 2 hours to dry it. Both feed types were then sub-divided into 3 containers of 20 g. each. Eight mealworms were weighed out and added to each of the 6 sub-divisions. A slight difference in growth has been noticed.

**#14 - MAPPING OF MINOR QTL FOR RESISTANCE TO DOWNY MILDEW IN GRAPE** Chelsea Campbell, Justin Conover, Daniel Pap, Summaira Riaz, Courtney Coleman, Andrew Walker, Biology. Faculty Advisor: Dr. Lazlo Kovacs.

Grape downy mildew (DM, *Plasmopara viticola*) is a pathogenic oomycete and the causal agent of one of the most serious diseases of grapevine (*Vitis* species). Originating in North America, it has now spread to all grape-growing regions of the world. If not treated by fungicides it can result in 50-100% crop loss. Currently DM is controlled by the recurrent application of pesticides, a practice that is both costly for the growers and harmful to the environment. Recently, a few East Asian grape species have been found to possess genetically encoded DM resistance that is thought to have evolved in the absence of DM and theoretically should not contain evolved resistance mechanisms. Because of this its resistance is of both plant breeding and evolutionary interest. The aim of this project is to map the genetic locus that determines the ability of the East Asian grapevine *Vitis piazeskii* to fight off this pathogen. Once a candidate gene from this study has been identified and verified, it can be deployed in grape breeding programs through conventional breeding or transgenesis to offer a natural source of resistance in commercial grape cultivars, and ease the environmental stress of fungicide application.

**#15 - EARLY LIFE STRESS CAUSES GUT DYSBIOSIS: IMPLICATIONS FOR CHRONIC PAIN CONDITIONS.** Orion Peterson, Shelby Harris, Jordan Hawkins, and Lauren Cornelison. Biology. Faculty Advisor: Dr. Paul Durham

Dysbiosis is an imbalance of the bacterial flora that populate the intestinal tract and is often seen in conjunction with health problems such as inflammatory bowel disease, obesity, and chronic fatigue. Stress is also a risk factor for these disorders, and is likely to impact the gut microbiota. Secondary traumatic stress is described as sensitization in a naïve individual elicited through exposure to an individual who directly experienced some trauma. Prior studies in our lab have shown that this sensitization may be transmitted vertically, but the mechanism by which this occurs is poorly understood. The goal of my study was to examine the effect of secondary traumatic stress on the diversity of gut flora, and the potential of microbial composition as a mediator to transmit and prolong sensitization between individuals. Male Sprague Dawley rats (sender) were subjected to forced swim testing (primary traumatic stress) and were co-housed with pregnant female Sprague Dawley rats (receiver). The offspring of females co-housed with stressed males had lower bacterial diversity in their gut than the offspring whose mothers were co-housed with non-stressed males. The results from my study provide evidence that secondary traumatic stress is comorbid with dysbiosis in the gut.

**#16 - ADMINISTRATION OF A CANNABINOID ENRICHED EXTRACT EXPRESSING LOW LEVELS OF THC STIMULATES INCREASED EXPRESSION OF MAP KINASE PHOSPHATASES IN TRIGEMINAL GANGLION NEURONS AND GLIA.** Cody Hyde and Jordan Hawkins. Biology. Faculty Advisor: Dr. Paul Durham

Cannabis, in the form of marijuana, has a long history of providing relief of pain, but the psychoactive effects of THC limit its medical use and social acceptance. Recently, extracts from Cannabis, containing high levels of CBD have shown anti-nociceptive potential without the side effects of THC, and may offer a novel therapeutic approach for treatment of episodic and chronic migraine. Migraine is characterized by a hyper excitable nervous system. Neuronal excitability is modulated by the interactions between kinases, proteins that promote sensitization and nociception, and phosphatases that maintain cellular homeostasis. We tested the hypothesis that a CBD extract would stimulate phosphatase expression and thus provide evidence for a possible mechanism for anti-nociception. Immunohistochemistry and image analysis was used to determine the levels of the MAP kinase phosphatases MKP-1, MKP-2, and MKP-3 in ganglia, spinal cord, and brain tissues. In addition, two different cognitive tests were performed including novel object recognition and spatial reference memory, which is known as the Morris Water Maze test. We found that a CBD extract did not impair cognitive abilities associated with short-term memory, but did cause an upregulation of MKPs in neuronal cells in the ganglion and spinal cord involved in pain transmission.

**#17 – INVESTIGATION OF MECHANISMS OF ACTION OF NOVEL ANTI-EPILEPTIC COMPOUNDS IN HIPPOCAMPAL CULTURES.** Jessi Allen, Lauren Cornelison, and Neelima Chelliboina. Biology. Faculty Advisor: Dr. Paul Durham.

Epilepsy is a neurological disorder characterized by unprovoked and reoccurring seizures. The condition is linked to heightened extracellular levels of the excitatory neurotransmitter glutamate. The goal of our study was to test the abilities of three novel experimental compounds to attenuate changes in protein expression when seizure-like conditions are simulated *in vitro*, as compared to an existing anti-epileptic drug. Epileptic conditions were simulated by exposing experimental hippocampal cell cultures (harvested from day 3-5 Sprague-Dawley rats) to a high $K^+$/low $Mg^+$ artificial cerebrospinal fluid for 30 or 120 minutes. Immunocytochemistry was used to evaluate the effects of each compound on protein expression with an emphasis on the protein GFAP to investigate astrocyte activity, the transport protein GLT-1 for its role in modulating extracellular glutamate concentration, and the signaling protein p-ERK for its stimulatory effect on neurons. Under unstimulated conditions, basal levels of GLT-1 were greatly increased when treated with experimental compounds as compared to the unstimulated control. The experimental compounds inhibited stimulated p-ERK and GFAP expression. These results were similar to those obtained using the approved anti-epileptic drug Leviteracetum. Results from my study provide evidence to support the further development of this line of novel drugs for treating epilepsy.

**#18 – VAGAL NERVE STIMULATION INHIBITS ACTIVATION OF TRIGEMINAL NOCICEPTIVE NEURONS IN A MODEL OF TRIGEMINAL SENSITIZATION.** Brian Blankenship and Jordan Hawkins. Biology. Faculty Advisor: Dr. Paul Durham

Recently, transdermal, non-invasive vagal nerve stimulation (VNS) was shown in clinical trials to be an effective treatment for high frequency episodic and chronic migraine. The goal of my study was to determine if vagal nerve stimulation could repress activation of sensitized trigeminal nociceptive neurons, which are implicated in the underlying pathology of migraine and temporomandibular joint disorders (TMD). Adult Sprague Dawley male rats were used to investigate the effect of stimulation of the vagal nerve in a model of trigeminal sensitization that mimics migraine and TMD pathology. A 10 minute exposure to a pungent extract from California Bay leaves (trigger), which stimulated V2 neurons, significantly increased the number of nocifensive withdrawals in response to mechanical stimulation of sensitized V1 and V3 trigeminal ganglion neurons mediated by neck muscle inflammation (risk factor) for at least 24 hours. VNS prior to trigeminal nerve activation did not block increased nocifensive responses. However, VNS administered 2 hours after the initial pungent odor exposure significantly inhibited the nocifensive response 100% of the time. Our findings provide evidence that VNS can abort V1 and V3 trigeminal nociception, and thus may be useful as a non-pharmacological therapy for episodic migraine and inhibiting pain associated with TMD pathology.

**#19 - INVESTIGATION OF CLINICALLY-ISOLATED BACTERIA DISPLAYING HIGH PHENOTYPIC RESISTANCE TO MANY COMMERCIALLY AVAILAVBLE SILVER-BASED WOUND DRESSINGS.** Shelby Harris and Rhy Norton. Biology. Faculty Advisor: Dr. Paul Durham

Silver has become a global treatment option, with the FDA providing marketing clearance for many silver-impregnated wound dressings and topical agents. However, the increased utilization of silver-based products across medical disciplines has raised questions concerning the development of acute silver-resistance. In this study, the viability of previously identified silver-resistant clinical bacteria (*Klebsiella pneumoniae* and *Enterobacter cloacae)* was further investigated in the presence of commercially available silver wound dressings. These microorganisms represent two of the most silver-resistant bacteria ever isolated from a clinical setting. To further explore the clinical significance of these isolates, multiple time-course and repeat-challenge assays were conducted with nine commercially-available silver-based burn and wound dressings utilizing a panel of silver-resistant and non-resistant microorganisms. For the non-resistant bacteria, the results revealed many dressings were able to maintain a high degree of efficacy over the course of 72 hours and during a repeated bacterial challenge. In stark contrast, both silver-resistant strains were largely unaffected and exhibited phenotypic resistance even when exposed to remarkably high silver concentrations found in commercially available burn and wound dressings. Our findings provide evidence that clinical bacteria are capable of maintaining silver resistance, which could significantly impact current practices in wound healing.

**#20 - DETERMINATION OF MAGNESIUM LEVELS IN MIGRAINE PATIENTS TREATED WITH A NOVEL MAGNESIUM SUPPLEMENT.** Andi Burroughs and Lauren Cornelison. Biology. Faculty Advisor: Dr. Paul Durham

Magnesium is used in the prevention and treatment of migraines, though the efficacy of this has not been soundly proven in clinical trials. Since many women who suffer from migraine have low serum magnesium levels, increasing serum levels via a dietary supplement should be therapeutically beneficial. However, there are many different forms of magnesium that differ in their bioavailability and solubility, and in addition there are also challenges to accurately measuring serum magnesium levels. When magnesium levels are low there is an increase in the sensitivity of the N-methyl-D-aspartate (NMDA) receptor to glutamate, which plays a role in the development of a hypervigilant migraine nervous system. The purpose of this study was to determine if a more readily bioavailable magnesium supplement (Magnesium-L-lactate-dihydrate or MLD10) could alter magnesium serum levels. Serum was collected at 5 timepoints from control subjects and subjects experiencing frequent episodic migraines, consistent with ICHD-3 beta criteria. Samples were stored frozen, shipped to CBLS, and were analyzed for ionized Mg, electrolytes, and creatine. Analysis of the serum samples was done with the use of the NOVA 8 instrument and data entered into RedCap. Magnesium levels will be correlated to the severity/frequency of headache reported by migraine subjects.

**#21 – CORRELATION BETWEEN LEVELS OF MAGNESIUM AND FREQUENCY/SEVERITY OF MIGRAINE.** Andi Burroughs, Chemistry. Faculty advisor: Dr. Paul Durham.

Magnesium is used in the prevention and treatment of migraines, though the efficacy of this has not been soundly proven in clinical trials. Since many women who suffer from migraine have low serum magnesium levels, increasing serum levels via a dietary supplement should be therapeutically beneficial. However, there are many different forms of magnesium that differ in their bioavailability and solubility, and in addition there are also challenges to accurately measuring serum magnesium levels. When magnesium levels are low there is an increase in the sensitivity of the N-methyl-D-aspartate (NMDA) receptor to glutamate, which plays a role in the development of a hypervigilant migraine nervous system. The purpose of this study was to determine if a more readily bioavailable magnesium supplement (Magnesium-L-lactate-dihydrate or MLD10) could alter magnesium serum levels. Serum was collected at 5 timepoints from control subjects and subjects experiencing frequent episodic migraines, consistent with ICHD-3 beta criteria. Samples were stored frozen, shipped to CBLS, and were analyzed for ionized Mg, electrolytes, and creatine. Analysis of the serum samples was done with the use of the NOVA 8 instrument and data entered into RedCap. Magnesium levels will be correlated to the severity/frequency of headache reported by migraine subjects.

**#22 - INVESTIGATING THE AFFECT OF SELECTIVE SEROTONIN REUPTAKE INHIBITORS ON INTRACELLULAR TRAFFICKING OF 5-HT$_{1B}$ .** Meagan D. Rippee, Chemistry. Faculty Advisor: Dr. Katye Fichter.

The molecular basis of major depression, one of several neuropsychiatric diseases, currently remains enigmatic. Mental health is becoming more of a topic for investigators to tackle because of the growing need for people who need help to lead normal, healthy lives with their condition. The basis at which this research lies is obtaining an understanding of a serotonin receptor, subtype 1B (5-HT$_{1B}$). This receptor has been implicated in major depression, as seen in brains of patients diagnosed with unipolar depression who committed suicide. In this project, the intracellular trafficking pathways of 5-HT$_{1B}$ will be quantified with single-molecule imaging. In preliminary experiments typical immunocytochemistry (ICC) experiments determine the intracellular location of 5-HT$_{1B}$ in resting states. This information will then be applied to future trials of similar work with antidepressants, specifically the selective serotonin reuptake inhibitor (SSRI) class, such as fluoxetine (Prozac) and sertraline (Zoloft), and their effect on the intracellular trafficking of 5-HT$_{1B}$.

**#23 - RESOLVING QUANTUM DOT CONJUGATES USING HYBRID GEL ELECTROPHORESIS.** Samuel P. Kasson, Chemistry. Faculty Advisor: Dr. Katye Fichter.

In our lab, quantum dot (QD)-antibody conjugates are synthesized for function as single-molecule probes of serotonin receptors. This project aims to characterize each product of this synthesis via gel electrophoresis. After synthesis, QDs must be chemically modified before becoming capable biomarkers. After solubilization in water, QDs are covered in ligands that terminate in carboxylates; these can be used as "chemical handles" to functionalize the QDs. First, carboxyl groups are activated and covalently bonded to polyethylene glycol (PEG); this increases water solubility and biocompatibility. Terminal carboxylate groups on the PEGs are activated, in a manner similar to above, and reacted with adipic acid dihydrazide (ADH). Hydrazide-functionalized QDs are then reacted with an oxidized antibody to produce a QD-antibody conjugate. Gel electrophoresis was used to characterize each product in this series of reactions. While most gels are either made of agarose, or polyacrylamide, we have found that hybrid gels afford better control over stability and pore size. We hope to resolve each product of the reaction sequence to determine the success of each conjugation.

**#24 - INVESTIGATING THE EFFECT OF SOLUBILITY AND LIGAND COATING ON THE QUANTUM YIELD OF INP/ZNS QUANTUM DOTS**

Greg Illy, Chemistry. Faculty Advisor: Dr. Katye Fichter

Our lab specializes in the synthesis of nanoparticle quantum dots (QDs) for biomedical application (*e.g.* theronostics, imaging, and drug delivery). A critical aspect in the development of the QDs is water solubilization (they are synthesized in organic solvents). We use a technique called ligand exchange to impart solubility of the QD in aqueous solvents. This process involves removing hydrophobic surface molecules from the QDs and replacing them with amphiphilic molecules, which impart solubility in aqueous solvents. The InP/ZnS QDs used in this experiment were synthesized in chloroform, and then underwent ligand exchange with 2 different ligands: mercaptoundecanoic acid, and dihydrolipoic acid. To identify the best ligand exchange method, we considered the brightness of the QD products, which can affect applications like single-molecule imaging. The brightness of the QD products can be measured by quantum yield, a measurement of the ratio of photons absorbed by the QDs to photons emitted through fluorescence. This experiment outlines the effect of ligand conjugation on the quantum yield of the QDs by comparison to a known standard (cresyl violet). Through this quantum yield analysis, we can study the effects of different ligands on the quality the QDs used in our lab.

**#25 – ISOLATION OF STABLE N2A (RAT NEUROBLAST) COLONIES EXPRESSING GFP-EEA1**. Brennon Foster, Chemistry. Faculty Advisor: Dr. Katye M. Fichter.

In this work, we aim to obtain cellular clones of Neuro 2a (N2a) cells stably expressing our gene of interest for an indefinite amount of time. The first step towards this is transfection, the process of inserting foreign genes into eukaryotic cells. There are two obstacles for isolation of stably transfected colonies: 1. non-transfected cells can overgrow transfected cells, and 2. transfected cells exhibit differing levels of gene expression. The purpose of this project was to overcome these obstacles to isolate stable colonies of N2a cells that express a subcellular marker protein: green-fluorescent protein (GFP) fused to early endosome antigen 1 (EEA1) gene. This protein will fluorescently highlight early endosomes in N2a cells. The long-term expression of this gene will allow us to follow the intracellular trafficking patterns of drug delivery vehicles and biomolecular probes. Currently we are running dose-response experiments with selective antibiotic (G418 sulfate) and different commercial transfection reagents in order to grow stable cell lines. We will use imaging as well as flow-cytometry studies to pick the best cell lines to use in future studies.

**#26 - WATER SOLUBILIZATION AND CHARACTERIZATION OF INP/ZNS QUANTUM DOTS**. Jacob Blankenship, Nick Mundt, and Matt Ellis, Chemistry. Faculty Advisor: Dr. Katye Fichter

Quantum Dots (QDs) are fluorescent semiconducting nanocrystals which fluoresce when excited by UV, or near UV light. QDs have narrow emission bands, allowing for multiplexed imaging, size tunable fluorescence -- the emission wavelength is dependent on the size of the QD core, which is easily controlled during synthesis, and are highly resistant to photobleaching. These properties allow for use as biomarkers, therapeutic agents, or sensors when attached to the correct affinity ligand, which could be an antibody or specific functional group. QDs are inherently insoluble in water due to native organic ligands bound to the QD surface. Many methods currently exist to solubilize QDs, but many have low yields, low stability, and often result in a shift of the emission wavelength of the QD. After a robust water solubilization method is found, future biomedical applications will be more easily explored in our lab. Described herein are water solubilization methods of previously synthesized InP/ZnS (Core/Shell) QDs utilizing a ligand exchange method using dihydrolipoic acid (DHLA), 11-mercaptoundecanoic acid (MUA), and mercaptopropanoic acid (MPA). QDs will be characterized via fluorimetery, NMR, and IR. A robust water solubilization method and characterization are the first steps to utilizing QDs in biomedical applications.

**#64 - RENEWABLE FUELS FROM NATURAL FATS AND OILS: COMPUTATIONAL MODELING OF FATTY ACID METHYL ESTER PYROLYSIS.** Michael Green, Chemistry. Faculty Advisor: Dr. Matthew Siebert

The search for a sustainable fuel with a smaller environmental impact led to biodiesel, a diesel replacement derived from triglycerides (fats and oils). To obtain biodiesel, one converts triglycerides into fatty acid methyl esters (FAMEs). Methyl oleate, one of the most prevalent FAMEs found in sunflower and canola oil, can be converted into other usable fuels by way of thermal cracking. In this study, we aim to accurately depict the thermal cracking of methyl oleate through use of quantum chemical calculations. Gaussian09 was used to compute the energy of reaction for several prototypical crackings, which are compared to experimentally determined values. The composite G3 method most accurately reproduces the experimental energies, but at a substantial computational cost. We aim to find a model chemistry that provides a better trade-off of accuracy to time. We hope that this research aids in finding a FAME that can be efficiently converted to fuel with high yield and from a sustainable source that is both domestic and inexpensive to create. This could lead to more jobs in the Midwest and farming regions of the US by production of a carbon-neutral fuel.

**#28- EXPLORING THE PHYSICAL CHARACTERISTICS OF A NOVEL PHARMACEUTICAL DRUG SOLUBILIZING AGENT, SOLUPLUS®.** Andrew Cheray, Karolina Kosinska, Chemistry. Faculty Advisor: Dr. Alan Schick.

Soluplus® is a compound manufactured by BASF Corp. with the intent to better solubilize poorly soluble drugs within aqueous biological systems. A novel triblock graft copolymer of polyvinyl acetate (PVA), polyethylene glycol (PEG), and polyvinylcaprolactam (PVCA), Soluplus® was originally designed to increase the bioavailability of drugs by safely enhancing the solubilities of drugs for better delivery within the body. Compounds of interest in drug delivery research tend to exhibit a number of interesting thermoreversible phase properties in solution, such as gel points and cloud points. The research reported here is intended to explore the phase behavior of Soluplus® aqueous solutions and specifically characterize gel-point behavior. Various concentrations were produced between 5% (w/w) and -30% in increments of 2.5% and gel points were measured by an inversion method. While 5% and 7.5% solutions did not gel at any temperature, concentrations equal to or greater than 10% showed an inverse relationship between Soluplus® concentration and gel point temperature. Greater Soluplus® concentrations also exhibited increased temperature ranges in which the solutions remained a gel before regaining flow. The gel point behavior is being evaluated in combination with other physical measurements made within our research group.

**#29 - UTILIZATION OF HIGH PERFORMANCE CLOUD COMPUTING TO PRODUCE INTERNET OF THINGS POLICY.** Jared Hall, Computer Science. Faculty Advisor: Dr. Razib Iqbal.

In today's world, technological data can be collected and processed in many different ways. As microprocessors have evolved to become faster, smaller, and more efficient, we are able to devise uses for them outside of the realm of traditional computational models. One relatively new way to use these microprocessors is to embed them in certain objects (cars, doors, swimming pools, etc.) and connect them via a network. This concept when combined with computer, mobile, and sensor networks is called the Internet of Things (IoT) and is thought to be the future of many data collecting systems. A problem of note in this emergent technology is to efficiently and quickly generate control policies for the IoT. Here we present a model which offers a potential solution to this problem. This is achieved by utilizing the n-tier scalability of the cloud to generate nested "pages" of virtual machines. These pages then process device level telemetry into device level policies which make up our IoT policy. This model is built with a particular focus on scalability to achieve near linear runtimes with respect to the number of computational units in a particular network.

**#30 - INVESTIGATING HUMAN BEHAVIOR AND PERFORMANCE IN IMAGE BASED PASSWORD SELECTION FROM A HCI PERSPECTIVE.** Casey Brown and Spencer Martin, Computer Science. Faculty Adviser: Dr. Razib Iqbal

The current standard for passwords has been alphanumeric passwords, found anywhere from bank PINs to Facebook. This means that there is usually a rigorous restriction on the number of special characters, capital letters, and numbers found in the password, as well as the length. With each additional level of password complexity, the task of memorizing the key becomes substantially more difficult for the user. By contrast, it can actually become easier to guess by an attacker, as users opt for easy to remember passwords involving personal information or common words. A step in a different direction begins with looking at non-alphanumeric objects for use as a password, such as images. When a user selects five non-ordered images from a pool of sixty-four images, the combination can be stronger than that of a normal alphanumeric password. Since we know that this method is cryptographically strong, we then examine how a user selects their images according to certain factors, such as age and gender. We also examine the difference in user performance between a user-chosen set of images and a system-provided set by observing length of focus and selection accuracy when asked to identify their images. The overall goal is to explore the behavior and performance of users with regard to images and image sets using a system that is image-oriented as opposed to alphanumerically-oriented.

**#31 - DEVELOPING TOOLS FOR WEB VISITOR ENGAGEMENT MEASUREMENT.** Matthew Scott, Computer Science. Faculty Advisor: Dr. Razib Iqbal

As revenues from Internet advertising continue to grow, advertisers seek popular web pages for placing advertisements in an effort to maximize profits. An important measure of how well a website is performing or how attractive it is to the advertisers is how engaged the web visitors are with that website. Besides academia, companies in the private sector are conducting research for marketers and suggest solutions for enhancing user interactions in an effort to maximize advertisement revenues. Hence, many tools have been developed or proposed to track web activities such as page views, bounce rates, clicks, scrolls, etc. Most of these tools however focus mainly on sporadic inputs and activities of the web visitors but lacks to report the actual level of engagement with the website. Our aim of this study is to be able to track how involved the visitor is from page load to when they finally close out of the page. We have investigated a simple technique to track the frequency of selected user activities in a particular website, which are then turned in to our proposed Active ratio and Focused ratio percentages. Our reporting mechanism is compatible with Google analytics so that the site owners can track the actual user engagement.

**#32 - AUTOMATED LICENSE PLATE DETECTION WITH OPENCV AND OPENALPR ON A RASPBERRY PI CLUSTER.** Jade Stobbe, Daniel Fennessey, Kaylen Bates, Aaron Rielly, and Sarah Gabbard. Computer Science. Faculty Advisor: Dr. Razib Iqbal.

Computer vision is a field that includes methods for acquiring, processing, analyzing, and understanding images from the natural world in order to produce numerical or symbolic information. Using the libraries, openCV and openALPR, our system is able to receive an image or video and detect license plates present in them. These images or videos are analyzed and processed on a Raspberry Pi cluster, which is a distributed system running Hadoop Map Reduce. If the cluster detects a license plate, then it will upload the license plate number, location, timestamp, and a snapshot of the vehicle to an online database. Our project was designed to help decreasing the response time of law enforcement officials in crime investigations involving vehicles. For example, if police were using our system, information gathered with our software can be cross referenced against a different database of active arrest warrants, stolen vehicles, amber alerts, or other crimes and our software will alert officials of seen vehicles of interest. In the future, we plan to enhance our our system so that officials could also generate maps of vehicle locations and predict possible routes of transit. However, application of our software is not limited to law enforcement agencies only. It could be repurposed for campus security, automated parking enforcements, or automatic gate operations.

**#33 - FENDER 5F1 CHAMP VACUUM TUBE AUDIO AMPLIFIER.** Chris Marquez, Jacob Rosenbaum, Tom Umphres and Ellis Lutz, Engineering. Faculty Advisor: Dr. Bob Egbert.
In this project, an instrument audio amplifier was built using vacuum tube technology with the purpose of understanding the engineering design process required to realize a complex electronic circuit from concept to completed product. The use of vacuum tubes (also referred to as valves, or simply tubes) in amplifier design has been well researched and documented and is a practice still widely used in high quality amplifier construction. The amplifier built for this project was based on a popular design (Fender Champ 5F1) and required the application of various theoretical, practical, and troubleshooting methods to understand and implement. The 5f1 design uses three valves; the 12AX7, 6V6, and 5Y3, for input voltage amplification, power amplification, and rectification, respectively. Transformers were used to supply usable power to the circuit from a common 120VAC receptacle and to drive the output speaker.

**#34 - INVESTIGATING THE POTENTIAL ROLES OF QUADCOPTER IN CARGO TRANSPORTATION AND AERIAL PERFORMANCE.** Derek Bloom, Nathan Burland, John Hampton, Joseph Whittington, Hunter Wichmann, Engineering. Faculty Advisor: Dr. Robert Egbert
Drones have recently been in the news due to their exploding popularity, availability, and ease of use. The goal of this project was to design and build a small quadcopter (drone) in such a manner that the design parameters would allow for it to be scaled up in order to accommodate different needs. As technology advances, the drone's parameters can be modified to allow for different cargo capacity, distance of travel, and performance specifications. Batteries and motors will become smaller and more efficient which will allow for greater traveling distances, and decreased transportation times. The advantage of this project could help military transportation, corporations, shipping industry, and individuals to deliver goods and materials and to perform aerial feats such as racing and surveillance.

**#35 - THERMOSTAT INTEGRATION USING Z-WAVE MESH NETWORK TOPOLOGY FOR WIRELESS HOME AUTOMATION CONTROL** Sarah Basham, Mason Marshall, Adam McGoon, Electrical Engineering. Faculty Advisor: Dr. Robert Egbert
Since the advent of household Wi-Fi, and increasing amount of home automation tasks have been incorporated into the house-wide network in order to enable the homeowner to control every aspect of the home, from the security system to the climate control. While this offers an immense amount of convenience, it consumes the bandwidth of the home based router. The Z-Wave network protocol came about to solve this. By acting as a standalone and purely local network the Z-Wave network operates through a mesh topology, meaning each device in the network can act as both slave and relay flowing back up to the router. Our team set out to take an existing Wi-Fi enabled Thermostat and modify it to allow a Z-Wave router to communicate with and modify the thermostat's functions. We created a Z-Wave daughterboard interconnect based on the Sigma Designs ZM5202 (an 8052 microcontroller variant). The UART serial communication protocol of the Wi-Fi module had to be translated into the Z-Wave protocol via the Keil uVision compiler.

**#36 - THE EFFECTS OF MICRO-INCLUSIONS ON INTERNAL STRUCTURE OF ZONED GARNET.** Jeremiah Cousins, Michael Sholtis, Gary S Michelfelder, Geography, Geology and Planning. Faculty Advisor: Dr. Gary Michelfelder.

Mineral inclusions are a key tool to understanding the complex history of geologic environments. Investigating the composition of inclusion and tying that information to growth zone compositions can provide detailed insight into changing thermal and chemical conditions in both igneous and metamorphic systems. Here we present an examination of micro-inclusions and garnet mineral chemistry on the internal structure of almandine-spessartine-pyrope garnets. We examine the effect of geochemical variation in the crystal structure as a function of diffusion rates of Mn (II) and Fe (III). The Tocantins area of NE Brazil produces both gem quality and highly included rhodolite garnets from a working mine on the Rodolita Farm. The garnets occur in mylonitic schist lenses of kyanite-staurolite grade in migmatitic gneisses. These garnets contain high-Mn cores and low-Mn rims and increase in Mg from core to rim. Fe content is within error from core to rim for all garnets analyzed. Preliminary analysis of the inclusions in the garnets range from aligned quartz, and Fe-Ti oxides. The substitution of Mg for Mn in the rims of the garnets not only produces a color change but cause fracturing perpendicular to the chemical zoning.

**#37 – STRUCTURE AND TWINNING IN MG- AND MN-RICH ZONED GARNET FROM THE TOCANTINS RHODOLITE GARNETS, TOCANTINS STATE, BRAZIL.** Michael J Sholtis, Jeremiah Cousins, Gary S. Michelfelder, Geography, Geology and Planning. Faculty Advisor: Dr. Gary Michelfelder.

The Tocantins area of North-East Brazil produces both gem quality and highly included rhodolite garnets from a working mine on the Rodolita Farm. The garnets occur in mylonitic schist lenses of kyanite-staurolite grade in migmatitic gneiss. These garnets contain high Mn cores and low Mn rims and increase in Mg from core to rim creating a color change from red in the core to purple in the rims. The substitution of Mg for Mn in the rims of the garnets not only produces a color change but cause fracturing perpendicular to the chemical zoning.

Mineral crystal structure is a primary tool used in understanding the intricate history of geologic environments. Decoding the crystal structure of garnets enables the determination of thermal and chemical conditions in both igneous and metamorphic systems that created them. We present an examination of the crystal structure and garnet mineral chemistry on the internal structure of almandine-spessartine-pyrope garnets. By using X-ray diffraction and secondary electron microscopy we have determined that twinning is the dominant control in fracture and crystal shape. Twinning occurs as pseudomerohedral ferroelastic twin lamellae that have preferred orientation that of twin domain boundaries parallel to (101).

**#38 – POPULATION PERSISTENCE AND CHANGE BETWEEN AFRICAN AMERICANS AND WHITES IN THE ST. LOUIS METROPOLITAN AREA FROM 1990-2010**. Hilliary Shumock, Jacquelyne Hooker, Geography, Geology and Planning. Faculty Advisor: Dr. Ron Malega.

The Michael Brown shooting and following events in Ferguson, Missouri, served as inspiration for this project and demonstrate the continued importance of race, class, and place in American society. The purpose of this study was to observe population persistence and change between African Americans and whites in the St. Louis Metropolitan area over a 20 year span. We used census tract data to identify where African Americans and whites were living and their annual income in the St. Louis metropolitan area in 1900, 2000 and 2010. We found that there is a spatial boundary separating the majority of the region's white and black populations and that this boundary has changed very little in the last 20 years. Furthermore, the St. Louis metropolitan still exhibits a high level of segregation of black-white residential segregation in 2000 despite improvements in residential integration between blacks and whites.

**#39 – OZARK STREAM RUNOFF MONITORING OF FOREST LANDS IN BURNED AND UNBURNED LANDSCAPES** Joe Nash, Geography, Geology and Planning. Faculty Advisor: Dr. Robert Pavlowsky, Marc Owens

The United States Forest Service manages the Mark Twain National Forest in southeast Missouri and employs forest rejuvenation techniques using prescribed burning with low temperature, ground level fires to increase soil nutrient levels and reduce competition among brush vegetation. This practice has led to local public concerns that burning is causing excess runoff resulting in persistent flooding which impacts local infrastructure and private property. The Big Barren Creek Watershed (191 km2) is a tributary to the Current River with about 92% forested land cover and 78% being National Forest lands. The purpose of this study is to quantify runoff rates during rainfall and snow melt events by installing discharge monitoring stations along small headwater streams and compare runoff trends among forests that have been burned or unburned. This study describes the initial installation and testing of the gage network including site selection, gage placement, runoff-stage calibration, and runoff hydrographs. Ten staff gage sites have been installed in the upper Big Barren Creek watershed. Gage sites include a staff gage, data loggers, and channel studies including cross-sectional surveys, longitudinal profiles, pebble counts and large woody debris tallies. This study will provide continuous stream flow and water temperature data through 2018.

**#40 - LEAD CONTAMINANTS LEVELS IN SPRINGFIELD MISSOURI ALONG ROAD WAYS.** Kelly Rose**,** Geography, Geology and Planning. Faculty Advisor: Dr. Robert T. Pavlowsky, Marc Owens

At concentrations of 400 ppm, lead poses a serious risk to the central nervous system and brain development in children. In Springfield, Missouri, there has not been a recent study of the lead concentrations in the soil along and on roadways in residential areas. In this study, several areas of Springfield had samples taken from the soil and road dirt in order to determine the lead concentrations in these areas. Some of the values were high, mostly in older residential neighborhoods, where there is a correlation to the age of the neighborhood and the lead concertation levels. According to the EPA, it is considered unsafe for the public at 1200 ppm in residential areas. The highest level that was tested in this study was site 5.1 at 1,677ppm, which is well above the EPA's guidelines. All of the samples were gathered from two separate sites, one being a younger neighborhood at the side south Springfield and the other was an older neighborhood in the Roundtree. The research was conducted by using an XRF machine to examine the samples for Pb, Zn, Fe, and Ca. High lead concentrations on road ways can cause the contaminates to run off into stream ways.

**#41 - CONODONT BIOSTRATIGRAPHY USED TO DETERMINE THE AGE OF AN ANOMALOUS BED BELOW THE BACHELOR FORMATION IN SOUTHWEST MISSOURI.** Misty Strickland, Geography, Geology, and Planning, Faculty Advisors: Dr. James Miller, and Dr. Charles Rovey

Southwest Missouri preserves a stratigraphic sequence of Mississippian-age rock units (mostly limestone) above older Ordovician dolomites. The basal Mississippian strata are characterized by the conodont genus *Siphonodella* (platform type), while the Ordovician strata contain distinctly different cone-type conodont genera. Recently we found thin limestone beds below the oldest recognized Mississippian (Bachelor) formation and directly above typical Ordovician (Cotter) dolomite at multiple sites near Branson, Missouri. At one site (Branson Airport Road) this limestone contains abundant *Siphonodella* elements, and hence is Mississippian in age. At a second site (Branson High Road) the limestone lacks Siphonodella, but contains a concentrated assemblage of unweathered (not reworked) Ordovician genera. Mississippian-age limestone beds have not been recognized previously beneath the Bachelor Formation, nor has Ordovician-age limestone been found above or within the Cotter. Therefore, these beds constitute rock strata that previously were unrecognized in Missouri.

**#42 - CALIBRATION OF A LOSS-ON-IGNITION TEST FOR ORGANIC MATTER AND CARBONATE IN SOILS FROM THE MISSOURI OZARKS.** Ashton Jones, Geography, Geology, and Planning. Faculty Advisor: Dr. Robert T. Pavlowsky

Loss-on-ignition (LOI) testing is an economical way to determine the organic matter and mineral carbonate content in soil samples. The method measures weight loss of carbon dioxide by heating or "igniting" the sample under controlled conditions in a muffle furnace to temperatures around 400 $^{o}$C for organic matter and 900 $^{o}$C for carbonate. This study develops and tests a LOI protocol for use in the analysis of soils and stream sediment samples from the Ozarks Highlands region of Missouri. The critical temperature for ignition can vary based on laboratory equipment, sample origin, regional geology, and vegetation. Samples of relatively known composition were used to calibrate the temperature settings by sequentially burning in a series of 100 $^{o}$C steps from 200 $^{o}$C to 1000. Ultimately, the test developed here will be used to address sedimentation and water quality problems in streams draining the Mark Twain National Forest.

**#43 - SEDIMENT SOURCE FINGERPRINTING USING MAGNETIC SUSCEPTIBILITY AND GEOCHEMISTRY IN BIG BARREN WATERSHED, MARC TWAIN NATIONAL FOREST, MISSOURI OZARKS.** Jameelah Rodriguez, Geography, Geology and Planning, Faculty Advisor: Robert T. Pavlowsky

Magnetic and geochemical properties of soil particles and stream sediments can be used to identify sediment sources and interpret stratigraphic trends in alluvial deposits. The purpose of this study is to apply sediment fingerprinting techniques to link sediment and soil sources to downstream floodplain deposition in Big Barren Creek. The disturbances from early logging activities, forest management including prescribed burning, modifications by landowners using levees and gravel mining to reduce flooding has effected sediment deposits. Analyses of sediment source samples from upland top- and sub-soils and upstream eroding channel beds and banks were compared to vertical trends in floodplain cores. Sediment mixing models and double-ratio plots were used to evaluate source to sediment sink relationships. This will be the first study to try to apply sediment fingerprinting techniques to understand fine sediment transport in Ozark watersheds.

**#44 - METALS STUDY IN CREEKS SEDIMENT IN AURORA MISSOURI: PH, COLOR, LOI, ICP-OES.** Jameelah Rodriguez, Misty D. Strickland, Ashton Jones, Ben Lockwood, Dylan T. Jones, Richard N. Biagioni, Geography, Geology and Planning, Faculty Advisor: Melida Gutierrez

Historic mining companies in Aurora, Missouri, disposed of waste in chat piles not visible today. Samples of creek bed sediments were collected to evaluate the current impact of residual mining wastes in Aurora, Verona and Marionville. These benthic sediments were analyzed to determine the levels metal contamination. After drying, crushing, and sifting the collected material, each sample was sent to a commercial lab for testing. Analysis was also conducted to determine the concentration of the heavy metals in the sediments and their exchangeability in nearby water pathways. Samples were selected for LOI for carbonate content measuring and pH levels. The Munsell color system was used to document sample colors. High contamination levels were plotted on a map to decipher a visible pattern in proximity to the old mining sites. The results indicated elevated levels of contamination that have a direct effect in Aurora but not in the surrounding towns.

**#45 - RECENT CHANGES IN RIVER FLOOD MAGNITUDE AND FREQUENCY IN THE OZARK HIGHLANDS, MISSOURI.** Emma E. Gibson, Geography, Geology and Planning. Faculty Advisor: Dr. Robert T. Pavlowsky

River flooding is often assumed to vary over time around a mean condition. However, previous research indicates that climate change and human activity can increase or decrease the average and maximum flood stages in a river. Effective planning and conservation initiatives rely on an understanding of changes in flood trends. The purpose of this study was to analyze the flood records for rivers in the Missouri Ozarks to determine if flood characteristics have changed over the last 30 years in comparison to the previous 30 year period. Historical annual peak flows from six USGS gage sites were analyzed for five rivers, ranging in drainage area from 1031 to 5278 $km^2$. PeakFQ software was used to evaluate flood recurrence intervals of 2-, 10-, and 100 years. 10 and 100 year floods generally increased in magnitude during the last 30 years at these sites, while most of the gages saw a decrease in 2 year flood magnitude. It is important to conduct further study to identify the causes of this trend. However, other river studies in the Midwest along with climate model predictions suggest that climate change due to global warming may be responsible.

**#46 - STATISTICAL ANALYSIS OF GEOCHEMICAL MARKERS IN KARST GROUNDWATER OF CENTRAL KENTUCKY.** Benjamin E. Lockwood, Geography, Geology, and Planning. Faculty Advisor: Dr. Douglas Gouzie

Most of the Inner Bluegrass region is underlain by Ordovician aged carbonates, and contains an abundance of karst features such as sinkholes, caves, and springs. Previous study results suggested that individual 'groundwater basins' may exist, where groundwater flow tends to occur mostly within one sink –cave (conduit)-spring system with almost no flow mixing into other 'groundwater basins.' Gouzie (1986) proposed that the karst groundwaters might develop unique geochemical 'signatures' related to rock units and surface land uses within each 'basin'. Gouzie (1986) found that a Discriminant Analysis function from the SAS program could yield roughly 90% accuracy in placing groundwater samples into the correct 'basin' based on geochemistry. This study revisits the earlier work by comparing a 2006 dataset collected as a 'blind sample set' to the samples reported in Gouzie (1986). The results focus on whether changes in land use over 20 years of urban growth around Lexington may mask accurate geochemical signatures or if the signatures remain useful even under conditions of urbanization. The geochemical signature method could become a valuable tool in other karst areas for quickly assess the areal extent of a drainage basin from simple groundwater analyses rather than more time intensive dye traces.

**#47 – INVESTIGATING THE CAUSES AND POSSIBLE SOLUTIONS OF CHINA'S SMOG PROBLEM.** Wenxi Yang, Geography, Geology, and Planning. Faculty Advisor: Dr. Timothy J. Brock

In Beijing, PM 2.5 exceeded the world standard for many times. Coal emission and economic growth were treated as a trade-off leverage in China. Burning coal, burning oil, burning organic materials industry, farms, chemical fertilizers, dust emission directly attributed to the initial pollutants for the smog in China. Besides the toxic emission materials themselves, the interaction between oil and coal burning made the air pollution worse. China was a big steel production country in the world. Steel production highly depended on coal industries. Over 60% steel firms have not completed the approval process from government on the environmental requirements. There were only two solutions to this air problem, either decrease the coal consumption or wash the coal to make it clean. In order to achieve this two goals, China needed a better management on environment. Studying from Britain and America, China could establish specific regulations with clear express, transform to clean resources, increase law enforcement and reform the market system of energy.

**#48- BRICK LAYING IN D-DIMENSIONAL EUCLIDEAN SPACE.** Justin Coyle, John Carter, and Jonathan Stacey, Mathematics. Faculty Advisor: Dr. Xingping Sun.

A d-dimensional brick is a d-dimensional rectangular region. Given a collection $\{B_k\}_{k=1}^{\infty}$ of congruent, non-overlapping bricks with edges $a_1,a_2,\ldots,a_d$, where $1 \le a_1 \le a_2 \le \cdots \le a_d \le 2$, assume (*i*) each edge of $B_k$ is parallel to a corresponding coordinate axis and (*ii*) the Hausdorff distance between the union $\cup_{i=1}^{\infty} B_k$ and $R$ is less than or equal to 1. Then a contraction map $f$ from $R^d$ to $R^d$, where $f$ is a bijection, can be found such that for each brick $B_k$, $\{f(B_k)\}_{k=1}^{\infty}$ will be a tessellation of bricks of the same size. The existence of this contraction map will be readily demonstrated in the 1-dimensional case, and examples in the 2-dimensional and 3-dimensional cases will be shown through an implementation of radial distance tests and movement of specified bricks to conjoining edges. We will also provide a method for confronting an obstacle when corners of bricks may overlap during the mapping process, the dependability of which will be proven. Ultimately, the existence of a general mapping in any dimension will be analytically proved and verified.

**#49 – SIMPLEXES IN AN N-DIMENSIONAL CUBE.** John Carter, Mathematics. Faculty Advisor: Dr. Les Reid.

Given a unit *n*-dimensional cube, we investigate the distribution of the measures of *k*-dimensional simplexes whose vertices are vertices of that cube. This includes determining the *k*-simplexes of largest and smallest measure as well as an analysis of the average value of these measures. We obtain an exact formula for the average length of 1-simplexes in an *n*-dimensional cube and show that asymptotically this length is $\sqrt{n/2}$. The distribution of the measures of higher-dimensional simplexes is more complicated, but we believe that the average measure of a *k*-dimensional simplex in a unit *n*-dimensional cube is asymptotically proportional to $n^{k/2}$. We present numerical evidence to support this claim.

**#50 – COMPUTATIONAL MODELING OF THE MECHANICAL AND HYDROTHERMAL STABILITIES OF MESOPOROUS MATERIALS.** James Thomas, Dayton G. Kizzire, Hayley Osman, R. Sakidja, R.A. Mayanovic. Physics, Astronomy and Materials Science. Faculty Advisors: Dr. Bob Mayanovic and Dr. Ridwan Sakidja.

Due to their high surface to volume ratio and nano-scale sized pores, periodic mesoporous materials have potential for heterogeneous catalysis, ion exchange, gas sensing and other applications. For energy harvesting for example, the mesoporous materials will need to operate under extreme conditions for maximum efficiency. However, studies of the stability of periodic mesoporous materials under extreme conditions are sparse. In this study, we use molecular dynamics (MD) simulations to investigate the stability properties of periodic mesoporous silica and aluminosilica having two-dimensional hexagonal pore structure. LAMMPS software is used on the Stampede supercomputer to simulate atoms interacting with simple Lennard-Jones potentials. Isostatic pressure is applied to the porous blocks until an equilibrium volume is reached. From the change in volume the bulk moduli are estimated. By repeating this at different pressures and pore volumes, the effect of porosity on the bulk modulus is modeled. Our MD simulations show that the bulk modulus value of periodic mesoporous silica varies exponentially with percentage porosity. Molecular dynamics simulations are being made in order to better understand how the pore architecture and the chemical composition (aluminosilicate vs silicate) of the host atomic-scale amorphous structure govern the stability properties of the mesoporous materials.

**#51 – A STUDY OF THE VARIABILITY OF YELLOW SUPERGIANT STARS.** John Crooke, Physics, Astronomy, and Materials Science. Faculty Advisor: Robert S. Patterson. From October 2015 until December 2015, 1 control pair and 7 sets of program yellow supergiant stars were observed at Missouri State University's Baker Observatory with a 0.36 meter Celestron Schmidt-Cassegrain hybrid telescope equipped with an Apogee Alta U77 CCD detector. Using IRAF, the images obtained were calibrated for differential aperture photometry. The Welch Stetson Index and standard deviations of average nightly delta magnitudes were used to determine candidates for variability. The selected candidates were then analyzed for periodicity. Two classical Cepheid stars were recovered. The rest of the stars were non-variable at the 1% precision level. Discussion of the location of these stars on the Cepheid instability strip is presented.

**#52 – MOLECULAR DYNAMICS STUDY OF LITHIUM-ION CONDUCTING PHOSPHATE GLASS.** Gavin Hester, Thomas Callaway, Physics, Astronomy, and Materials Science. Faculty Advisors: Dr. Saibal Mitra and Dr. Ridwan Sakidja.

Recently, amorphous solid electrolytes have seen considerable interest as a possible replacement to conventional liquid electrolytes. Liquid electrolytes often suffer poor thermal stability and develop dendritic shorts, which a solid electrolyte can mitigate. A promising solid electrolyte system is $xLi_2SO_4$-$(1-x)(Li_2O$-$P_2O_5)$. This study aimed to computationally replicate the experimental measurements performed on this system. The classical molecular dynamics program, LAMMPS, was used to model the system. A combination of Morse, Coulombic, harmonic, and exponential potentials were used to calculate the molecular dynamics. The crystalline $LiPO_3$ system was melted, quenched to room temperature using the NPT thermostat, where diffusion measurements were performed. In adding sulfate, the phosphorus atoms were replaced with sulfur to obtain the desired composition. We observe that the computational mean-square displacement (MSD) measurements agree nicely with experimental data previously obtained. Results will be discussed in terms of how the diffusion and structure is affected by the sulfate and how the structure facilitates diffusion.

**#53 - SEPERATING DWARFS FROM SUBGIANTS FOR THE NASA TESS MISSION USING WISE PHOTOMETRY** Joseph Huber, Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Peter Plavchan.

The goal of the Transiting Exoplanet Survey Satellite (TESS) mission is to find small transiting planets around bright main sequence stars. More specifically, I have focused on the challenge of selecting the appropriate host stars – bright cool dwarfs – from the TESS transit Candidate Target List (tCTL). For example, a faraway giant star can appear to be similar to a nearby dwarf star of the same surface temperature, and it is impractical to find transiting planets around giant stars. Thus, it is difficult to reliably select host stars, so we have begun to explore the possibility of separating dwarfs from subgiants using WISE (Wide-field Infrared Survey Explorer) and 2MASS (Two Micron All Sky Survey) colors, thus disambiguating subgiants from dwarfs for G, K, and M spectral types. To accomplish this we are adapting code in IDL (Interactive Data Language) to automate the process of determining the spectral type and luminosity class of a sample of well-characterized stars.

**#54 – ELECTROMAGNETIC PROPERTIES OF 2-DIMENSIONAL TUNGSTEN-TELLURIDE GROWN IN ULTRA-HIGH VACUUM** Trey Grimes, D.Soden, Dr. D. Cornelison, and Dr. K. Ghosh, Physics, Astronomy, and Materials Science. Faculty Advisor: David Cornelison

In 2014, the semi-metallic compound Tungsten Telluride was shown to exhibit extreme magnetoresistant properties[1]; properties that could have a wide range of applications in the electronics industry. Our group at MSU is attempting to investigate the properties of 2-dimensional $WTe_2$ thin films. We synthesized our own compound in evacuated quartz ampoules in a 3 day annealing process. XRD and EDS characterization has shown the compound to have successfully formed $WTe_2$ powder. The next stage will involve growing the thin film via pulsed laser deposition. This will be done in an ultra-high vacuum environment that is achieved using a turbo-molecular pump in tandem with an ion-pump in a chamber designed and built by our team to achieve $10^{-9}$ torr.

**#55 - FUNCTIONALIZATION OF DEFECT DENSE GRAPHENE AND A COMPARISON WITH MOLECULAR DYNAMICS SIMULATION,** Dan Jones**,** Physics, Astronomy, and Materials Science. Faculty Advisors: Dr. Kartik Ghosh and Dr. Ridwan Sakidja.

I investigate the pH-dependent surface functionalization of few layer graphene and graphene oxide (GO) with a comparison of experimental and computational results. It has been discovered that the defect density of aqueous graphene and GO has a strong pH-dependence, the effect of which can be quantized using the D/G ratio of the corresponding Raman spectra. The effect of low vacuum annealment of drop casted samples on $SiO_2$ substrates is evaluated via the same D/G ratio, and the effect is found to be a slight elimination of pH-dependence. The experimental results can be verified by a comparison to molecular dynamics simulation of a generated Raman spectrum at various defect densities. This verification is difficult because the defects can arise from a multitude of sources. This examination focuses on defects arising from hydration of surface dangling bonds—a likely result of lowering the solutions pH. The Raman spectra are then correlated to the experimental D/G ratios, and the two spectra are compared, paying specific attention to the wavenumbers, FWHM, intensity, and intensity ratios of the D, G, and 2D peaks. The simulation studies can again be extended to include the effect of annealment before generating a Raman spectrum at various defect densities.

**#56 - MICRONERVA: ACTIVE GUIDING TECHNIQUES FOR AN AUTOMATED TELESCOPE ARRAY.** Ryan Hall, Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Peter Plavchan

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

**#57 - USING KEPLER SPACE TELESCOPE DATA TO UNDERSTAND PULSATING HELIUM FUSING STARS**. Laura Ketzer, Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Mike Reed.

The unprecedented photometric data acquired by the Kepler space telescope has enabled asteroseismologists to study compact pulsating stars in great detail, in order to learn more about their stellar interiors. With Kepler's continuous observations, g-mode pulsations with periods ranging from 0.5 to 2 hrs, and p-modes with periods on the order of several minutes can be more easily identified in subdwarf B (sdB) stars. These stars are located on the extreme Horizontal Branch and fuse helium to carbon in their cores. During the extended Kepler mission (K2), only unprocessed data are supplied and significant effort is required to remove spacecraft artefacts. The data is then analyzed using a Fourier analysis, and pulsations are identified into modes. By characterizing the various pulsation modes present in a star, and by examining the time-dependence of pulsation amplitudes, we can create or adapt structural models of the interiors of sdB stars. This is a promising approach to enhancing our understanding of sdB stars.

**#58 - OBSERVATIONS OF EXOPLANETS WITH THE KEPLER SPACECRAFT**. Shannon Dulz, Physics, Astronomy, and Materials Science. Faculty Advisor: Dr. Mike Reed

The NASA Kepler project sought to find Earth-like planets at an Earth-like distance from its star. It used the transit method of exoplanet detection to find thousands of planetary candidates while observing the same portion of the sky during its four-year mission. While Kepler was largely unable to detect Earth-sized exoplanets at Earth-like distances, further analysis of the light curves and meticulous removal of spacecraft artifacts from the data may yield more information on the features of Earth-like systems. The goal of this project is to look for transit timing variations, dayside albedo and reflection asymmetries in the light curve of a known Earth-sized exoplanet.

**#59 - MICRONERVA: A NOVEL APPROACH TO LARGE APERTURE ASTRONOMICAL SPECTROSCOPY.** Claire Geneser, Physics, Astronomy, and Materials Science Faculty Advisor: Dr. Peter Plavchan

The goal of MICRONERVA (MICRO Novel Exoplanet Radial Velocity Array) is to show that the combined light from multiple 8-inch telescopes is just as effective for taking spectroscopic radial velocity measurements as that of a larger telescope, at a reduced cost to the researcher. This paper analyzes the process of programming a single, 8-inch CPC Celestron telescope to actively guide on a target star within an accuracy of better than one arc second. A four telescope system will then be built to imitate the same light gathering power as a 16-inch telescope, such as the Cassegrain reflector housed at Baker Observatory. Our model tests the pricing to search for exoplanets using the array for discovery by the Doppler spectroscopy technique. All hardware is controlled using Python commands, along with ASCOM drivers. The results open possibilities to perform this research at a fraction of the former cost.

**#60 – REPORT ON ATOMISTIC MODELING OF BONDING IN CARBON-BASED NANOSTRUCTURES**. Timothy Stillings, Physics, Astronomy and Materials Science. Faculty Advisor: Ridwan Sakidja

In this study, modern ab-initio calculations using Density Functional Theory implemented by VASP are compared with classical molecular dynamics calculations using Tersoff and AIREBO potentials to assess their accuracy as in describing the bond mechanisms within a C70 molecule as well as the inter-molecular bonding between two C70 molecules in close proximity. It was found that the DFT calculations provided the most accurate results, but calculations done with AIREBO potentials correlate well with the DFT calculations. Tersoff potentials, on the other hand did not perform well and overestimated the bond lengths. We further assess the chemical bonding mechanisms through the mapping of the charge density as a result of the DFT calculations.

**#61 – MICRONERVA: ROBOTICALLY DETERMINING TELESCOPE ORIENTATION WITH AN ARDUINO BOARD.** Frank Giddens, Physics, Astronomy and Materials Science. Faulty Advisor: Dr. Peter Plavchan

The future of exoplanet discoveries with the radial velocity or Doppler technique requires the deployment of many automated, low cost telescope observatories. To achieve these goals, we are working on developing the MICRONERVA project, which is a prototype array of four eight-inch diameter, computer controlled telescopes. One key requirement of a telescope is to know accurately where it is pointed. For the telescopes in the MICRONERVA array, it is difficult to use the existing hardware to acquire this information. Thus, we have worked on a low cost Arduino board equipped with an accelerometer and magnetometer to derive a telescopes absolute pointing in altitude and azimuth. In this paper, we present our current progress in developing and controlling this sensor. We outline future efforts and how it will be incorporated into the robotic software for the MICRONERVA facility.

**#62 - THE EFFECTS OF NANOPARTICLE SIZE ON THE PROPERTIES OF SIMULATED SIO2 MELTS**. Kent Mastroianni, Physics, Astronomy and Materials Science. Faculty Advisor Dr. Ridwan Sakidja

Molecular dynamic simulations can help to understand the behavior of $SiO_2$ nanoparticles under extreme conditions. This project utilizes the molecular dynamics (MD) simulation package Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) to study the effects of SiO2 nanoparticle size on the properties of melting and glass transition. Nanoparticles of Silica with accurate inter-atomic positions will be created as inputs for the LAMMPS simulation under a constant volume and temperature (NVT) canonical ensemble simulations. Changes in the melting point and glass transition temperature are to be evaluated by varying the size of the silica nanoparticles and the heating/cooling rates.

**#27 - COMPARISON OF ALUMINIDE DIFFUSION COATINGS ON VARIOUS STEEL SUBSTRATES SYNTHESIZED BY PACK CEMENTATION.** Zach Leuty, Physics, Astronomy and Materials Science. Faculty Adviser: Dr. Sakidja Ridwan.

To increase the efficiency of steam power plants, operating temperatures must be raised above 650ºC. Even stainless steel corrodes very rapidly under these conditions. Aluminum diffusion coated steel is extremely corrosion resistant under these high-temp, high pressure, water vapor conditions. The aluminizing process is typically performed at 900º-1000ºC, which inevitably degrades the mechanical integrity of the steels structure. Recent advances in pack-cementation show that a low temperature (650ºC-750ºC) aluminizing is feasible using certain halide salt activators. In this study, the growth kinetics are examined to see how they are affected by selecting a different steel substrate (18-8 stainless steel, low chromium alloy steel, no chromium machine steel), halide salt activator (ammonium chloride, ammonium fluoride), growth time, and furnace temperature. It was found that chromium in the steel substrate can inhibit the growth process, therefore coatings on stainless steel are thinner. A higher iron content in the steel creates a thicker coating. Chloride based activators create a thicker coating than fluoride based activators. There is also a positive direct correlation with the temperature/time and the thickness of the diffusion coating. In the future, an oxidation test between these coated materials will be conducted to quantify which coating/substrate combination in more resistant to corrosion.