#1 - GREEN ROOF USE BY BIRDS AND THE EFECT THAT THE SURROUNDING ENVIRONMENT HAS ON THEIR BEHAVIOR. Alex Meinders, Biology. Faculty Advisor: Janice Greene.

With the rise in practicality and popularity of the green roof in America comes the need for further study of their effect on the surrounding wildlife. With Germany at the fore-front of green roof technology beginning in the 1970s it spread to the rest of Europe much quicker than it has in America. Most of the research has focused on the beneficial effects that green roofs have on solar radiation, water run-off and insulation for the buildings that they are installed on. Three game cameras were set up on the green roofs of The Discovery Center and Dynamic Earth which are both located within Springfield, Missouri. The cameras were set up for four to five days at a time at each location totaling up to about two weeks of footage for each camera at each site. Very few birds were observed making use of the two green roofs in this study. A total of four birds for the Discovery Center and three reoccurring birds for the roof of Dynamic Earth were detected. Though the sample size is low the activities of the birds observed at each location does differ entirely. Further study needs to be completed during the growing season.

#2 – ASSESSMENT OF CARBON NANOTUBE TOXICITY TO THE MOTH SPECIES *PLUTELLA XYLOSTELLA*. James M. Fischer, Biology. Faculty Advisor: Alexander Wait.

Carbon nanotubes (CNTs) are a fairly new discovery, but they are currently found in over 15% of all consumer products. Their accidental release during processing or release from consumer products in landfills is possible. However, little is known about their potential toxicity to plants and animals. The overall purpose of my experiments was to evaluate the effects of CNTs on a crop pest *Plutella xylostella* I measured the direct effects of CNTs on moth larval growth and feeding, that is when CNTs were directly consumed in artificial food. I also measured indirect effects of CNTs on larval growth and feeding, that is when *Arabidopsis thaliana* grown in media containing CNTs were fed to the larva. In preliminary trials, CNT concentrations of 4.32mg/L and 8.64mg/L in artificial food were observed to marginally increase growth of larva but have no effect on consumption rates of the artificial food. This certainly indicates the concentrations used were not toxic. There were no differences in consumption by, or growth of, *P. xylostella* when feeding on *A. thaliana* grown in CNT agar. CNTs are not directly taken up by plants, so this result indicates the CNT concentration did not alter the quality (i.e., nutrient content or secondary chemical content) of *A. thaliana*.

#3 – EXAMINING THE TOXICITY OF CARBON NANOTUBES ON GROWTH OF *ARABIDOPSIS thaliana*. Amelia B.R. Chiles, Biology. Faculty Advisor: Alexander Wait.

Carbon nanotubes (CNTs) are a relatively new discovery that are used as drug delivery molecules, in fuel cells, as imaging agents in medicine, in electronics (e.g., cell phones), in combat jackets, in consumer products like sunscreens and cosmetics, and have applications is agriculture. Toxic effects on living organisms are possible, but have been studied very little. CNTs can enter the environment at the point of processing (i.e., when they are pure) and in products in landfills (i.e., when they have been functionalized and altered for use in products). However, even with their widespread use, there are virtually no experiments examining the effects on CNTs on whole plants. I examined the potential toxicity to *Arabidopsis thaliana* (mustard) grown in pure CNTs. *A. thaliana* plants grown in CNTs were not negatively affected as determined by measuring biomass, photosynthesis and water potential, which are indicators of growth, carbon uptake and water stress, respectively. These results suggest that pure CNTs at concentrations normally required for manufacturing applications would not be toxic to plants in the environment. However, future research needs to examine the effects of CNTs that have been functionalized (i.e., altered) for use in products.

#4 – METHODS OF AGING BLUEGILL SCALES TO DETERMINE AGE-LENGTH REGRESSIONS OF POPULATIONS IN WISCONSIN LAKES. Stephanie Sickler, Biology. Faculty Advisor: Daniel Beckman.

Scale age data can be useful in a number of circumstances, including age-at-length regressions and mortality rates. For this study I aged bluegill (*Lepomis macrochirus*) scales to compare with length to determine if the presence of the invasive plant Eurasian watermilfoil (*Myriophyllum spicatum*) causes stunting of bluegill growth. This may potentially be the case in two of the lakes studied. My efforts in this study focused on finding the most accurate and efficient way to age the scales. The method used was to dry mount the scales between two glass slides and use a dissecting microscope with transmitted light to view the annuli. The anterior, or outer, side of the scales should face up, and the flat end of the scale should be at the top with the rounded end at the bottom. There are several defining characteristics of annuli in scales, but not all scales may present all of the characteristics. Some of the most common characteristics for bluegill annuli are cutting-over, bell marks, and changes in the location of radii. Relative spacing of the circuli is one of the most commonly used characteristics for determining annuli, however it was determined that this method was unreliable for bluegill scales.

#5 – USE OF VISUAL AND CHEMICAL CUES DURING PREDATOR DETECTION IN THE RAINBOW DARTER, *ETHEOSTOMA CAERULEUM*. Kendell Loyd, Biology. Faculty Advisor: Alicia Mathis

Rainbow darters (*Etheostoma caeruleum*) use both visual and chemical cues to gather information from their environment, such as identifying potential threats. It is unknown if *E. caeruleum* favors one stimulus modality when distinguishing between predatory and non-predatory species, or if a combination of both visual and chemical cues is more advantageous. Darters were exposed to the chemical cues of a predator, Ozark sculpin (*Cottus hypselurus*); a non-predator, northern hogsucker (*Hypentelium nigricans*); or dechlorinated tap water. Rainbow darters had a significantly longer latency to move when exposed to cue from Ozark sculpin, but not when exposed to that of northern hogsucker or control. Darters also moved significantly less when exposed to the Ozark sculpin cue than when exposed to the northern hogsucker or the control. These results indicate that *E. caeruleum* are able to identify predators via chemical cues alone. Preserved Ozark sculpin or northern hogsucker specimens were then presented to darters through glass jars to prevent access to behavioral or chemical stimuli. Darters reacted to both Ozark sculpin and northern hogsucker by showing a greater latency to move than when exposed to an empty jar, thus suggesting that the darters identified both as predatory.

#6 – FULLERENOLS ALTER GROWTH AND PROTEIN ACTIVITY IN YEAST CELLS. John C. W. Short, Biology. Faculty Advisor: Kyoungtae Kim.

Fullerenols are polyhydroxylated carbon nanoparticles with greater water solubility than carbon nanotubes making them more attractive as a material for novel medical uses, yet their effect on living systems is not well understood. We examined the changes in growth rate and global gene expression profile upon treatment of the fullerenol C60(OH)24 on the budding yeast, *Saccharomyces cerevisiae*, as a model of basic eukaryotic systems. Our findings showed a negative impact on the growth rates, doubling times, and final density of yeast in complete media. We report the first complete transcriptome RNA-Seq analysis of yeast exposed to carbon nanoparticles, identifying differentially expressed genes implicated in a broad range of cellular functions, many of which are known to be up- and down-regulated by other environmental stress factors. The changes are brought about by subtle interactions that have not been fully elucidated. Further research will investigate the effects of long-term exposures and the trafficking pathway of these nanoparticles throughout the cell.

#7 - TOXICITY OF CARBON NANOTUBES TO BUDDING YEAST. Sara E. Woodman, Biology. Faculty Advisor: Kyoungtae Kim.

Carbon nanotubes (CNTs) are a class of cylindrical nanoparticles with the possibility for diverse technological and biomedical applications. As CNTs are more frequently incorporated into products, the risk of environmental exposure due to leaching or manufacturing byproducts will likely increase. Therefore, the potential toxicity of CNTs to cells and tissues is an important question in nanotechnology. To assess the toxicity of CNTs, we used the budding yeast *Saccharomyces cerevisiae*, one of the simplest eukaryotic organisms that shares fundamental aspects of eukaryotic cell biology. We found that treatment with carbon nanotubes negatively affected the growth rates, end-point cell densities and doubling times of CNT-exposed yeast cells when compared to unexposed cells. To investigate potential mechanisms behind the CNT-induced growth defects, we performed RNA-Seq dependent transcriptional analysis and constructed global gene expression profiles of control and CNT-treated cells. When compared to nontreated control cells, CNT-treated cells displayed differential expression of genes whose functions are implicated in membrane transport and the cellular stress response. Taken together, we propose that CNTs could serve as an environmental stress factor that negatively affects eukaryotic cells.

#8 - CHANGES IN MEMBRANE LIPID COMPOSITION DISRUPT YEAST PROTEIN RECYCLING. Justin Conover, Chris Trousdale, Biology. Advisor: Kyoungtae Kim

Protein recycling is an essential cellular process that involves endocytosis, intracellular trafficking, and exocytosis. It has been shown in mammalian systems that membrane lipids, including cholesterol, sphingolipids, and phospholipids, play a pivotal role in protein recycling. In order to address the roles of yeast plasma membrane lipid components on protein recycling, we utilized GFP-Snc1, a receptor protein serving as a fluorescent marker for faithfully reporting the recycling pathway. Here we show results that display moderate to significant GFP-Snc1 recycling defects upon overexpression or deletion of phospholipid biosynthesis enzymes, as well as defects in deletions of ergosterol biosynthesis enzymes. We also report the extent of GFP-Snc1 recycling in the presence of a sphingolipid drug that inhibits sphingolipid synthesis. Together, the homeostasis of membrane lipid levels is prerequisite for proper protein recycling.

#9 - PHENOTYPING A SEGREGANT MAPPING POPULATION OF *VITIS PIASEZKII* X *VITIS VINIFERA* HYBRIDS FOR QUANTITATIVE TRAIT LOCI ANALYSIS FOR RESISTANCE TO *PLASMOPARA VITICOLA*. Justin Conover, Chelsea Campbell, Daniel Pap, Summaira Riaz, Courtney Coleman, Biology. Advisor: Laszlo Kovacs

Plasmopara viticola is an oomycete and the causal agent of downy mildew in grapevines. It originated in North America, but was accidentally transferred to Europe in the late 1870s. *P. viticola* has since spread throughout the world where grapes are grown, including Europe, South America, Australia, and South Africa and can cause between 50-100% of crop loss if not treated by fungicides. No natural form of durable resistance is currently commercially available. This study is attempting to locate quantitative trait loci (QTL) responsible for natural resistance to downy mildew in *Vitis piasezkii*, a Southeast Asian grape species. Because *V. piasezkii* evolved in the absence of downy mildew and theoretically should not contain naturally evolved resistance mechanisms, its resistance to this pathogen is of interest not only from a plant breeding perspective, but from an evolutionary perspective as well. The purpose of our project is to characterize the genetic basis of resistance utilized by this grape species. 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.

#10 – INVESTIGATING THE GENETIC COMPONENT OF ROOTING PATTERNS IN *VITIS RUPESTRIS* AND *VITIS RIPARIA*. Chelsea N. Campbell, Biology. Faculty Advisor: Lazlo Kovacs.

The Ozarks region is home to a variety of grapevine species, two of which are *Vitis rupestris* and *Vitis riparia*. The *former* grows almost exclusively on nutrient-poor rocky riverbanks and gravel bars along streams, requiring it to root deeply to reach water and nutrients. The deep roots of *V. rupestris* allow it to tolerate drought and salinity better than most other grapevine species. *V. riparia*, an evolutionary close relative of *V. rupestris* also grows along rivers, but almost exclusively on moist, alluvial soils of floodplains. This species is poorly adapted to drought and nutrient-poor conditions. It has been proposed that the obtuse angles and laterally emerging root system of *V. riparia* is an adaption to this moist soil condition. My work is to test the hypothesis that a correlation exists between these two taxa and the growth habit of their roots. I have tested this hypothesis by rooting cuttings of these two species in the same growth medium and measuring the angle at which their roots emerged. Knowing if this trait is environmentally or genetically determined has implications to better understanding plant adaption and breeding grape varieties that will enable sustainable production under various drought and soil nutrient conditions

#11 – EFFECTS OF A SINGLE EXON RESISTANCE GENE AGAINST POWDERY MILDEW ON VITIS VINIFERA. Natalie L.Venette and Courtney Coleman, Biology. Faculty Advisor: Lazlo Kovacs.

Resistance genes to specific pathogens are essential to develop sustainable agriculture. Powdery mildew (PM, *Erysiphe necator*) is a fungus that infects cultivated grapevine plants (*Vitis vinifera*) and destroys their photosynthetic tissues. *V. vinifera* have evolved resistance genes to counteract the infection of *E. necator*. Sources of resistance were detected and mapped on the *REN1* region of grapevine chromosome 13. Based on this map, several BAC clones were identified that contained candidate resistance (R) genes. These R genes were predicted previously using sequence analysis software by a graduate student. Four candidate genes were found, and two of them have been cloned and inserted into transgenic *Arabidopsis* for functional analysis. My project involves the cloning of a coiled-coil-type R gene containing a single exon of 4328 bp, a prime candidate for conferring PM resistance. I designed a cloning strategy in which I will excise a DNA fragment of the gene using *Cla*I enzyme and insert it in a cloning vector. Subsequently, the gene will be equipped with an adapter that will facilitate its subcloning into an *Agrobacterium* binary vector. The gene will then be inserted into the genome of *A. thaliana* to test its functionality.

#12 - INVESTIGATING THE EFFECTS OF CARBON NANO-STRUCTURES ON GENE EXPRESSION IN PLANTS. Vince Balassi, Karolina Kosinska, Alexander Linan, Yingcai Su and Alexander Wait, Biology. Advisors: Laszlo Kovacs

Recently, carbon nanostructures have emerged as promising new materials for the construction of improved electrical circuits and other equipment. However, there is limited information on how these materials affect living organisms in the environment once they have been discarded. The effects of carbon nano-tubes (CNTs) and polyhydroxy fullerenes on gene expression in the model plant species *Arabidopsis thaliana* have been examined using RNA-seq technology. Previously, *A. thaliana* was grown on plant media supplemented with different carbon nano-structures and on standard medium (control) in triplicates (3 treatments x 3 replicates) under identical conditions by another student. Global gene expression in these plants was analyzed by RNA-seq, and several genes were identified as responsive to carbon nanostructures. This experiment was repeated the following year. We used the Galaxy transcriptome analysis software and qPCR to validate the data of our RNA-seq experiment and to compare results of the first and second experiments. We repeatedly failed to confirm the results of the first experiment, which suggests that the impact of carbon nanostructures on *A. thaliana* plants under these culture conditions is so slight that it cannot be detected even with the most sensitive molecular techniques.

#13 – SEASONAL SEX RATIO VARIATION OF GRAY BATS *(MYOTIS GRISESCENS)* NEAR A HIBERNACULUM IN SOUTHWEST MISSOURI. Dana Green and Cheyenne Gerdes, Biology. Faculty Advisor: Lynn Robbins

Sex ratio data of a *Myotis grisescens* population at a single large hibernaculum were studied across the winter and following fall and spring hibernating season by month. During the fall of 2013, a trend was observed skewing the expected 1:1 sex ratio. The ratio of males in early fall outnumbered that of females by 2:1 in September (N=40) and then reversed one month after in October to a 1:5 ratio (N=48). The previous hibernation season, December 2012-February 2013, the ratio of males to females was close to a 1:1 ratio and remained that way until early spring. From March to April of 2014 a trend of declining male presence was observed, changing from 4:1 in March (N=22) to 1:4 sex ratio in April (N=27). This trend suggests that males arrive first in fall in order to have first male advantage to breed, and leave first in order to establish territory in male summer and reduce competition with females for spring resources.

#14 - CGRP ANTAGONIST INHIBITS CYTOKINE EXPRESSION IN MODEL OF TEMPOROMANDIBULAR JOINT DISORDER PATHOLOGY.
Lindsey Koop, Jordan L. Hawkins, and Lauren Cornelison, Biology. Faculty Advisor: Paul L. Durham.

Temporomandibular joint disorder (TMD) is characterized by pain localized to the temporomandibular joint (TMJ) and muscles associated with mastication. TMD pathology involves activation of primary nociceptive neurons that promote peripheral sensitization and excitation of second order neurons implicated in the development of central sensitization. Elevated levels of calcitonin gene-related peptide (CGRP) and cytokines in the TMJ and spinal cord occur in TMD pathology. In my study, I tested the hypothesis that CGRP plays an important role in the initiation and maintenance of central sensitization by inhibiting CGRP-mediated upregulation of cytokines. To inhibit the cellular effects of CGRP, Sprague-Dawley rats were injected (i.t.) with $CGRP_{8-37}$, a CGRP antagonist, before injection of the inflammatory agent CFA into both TMJ capsules. Upper spinal cord tissue was removed at 2 hrs and 7 days post injection and analyzed for changes in cytokine levels through immunohistochemical staining of spinal microglia and astrocytes, and cytokine array analysis of 29 cytokines. Treatment with $CGRP_{8-37}$ inhibited cytokine expression and suppressed microglia and astrocyte activation. In conclusion, results from my study provide evidence that $CGRP_{8-37}$ reduces the inflammatory effects within TMD pathology by reducing excitatory ability of CGRP receptors, and thus may be a useful therapeutic strategy for TMD.

#15 - ROLE OF CALITONIN GENE-RELATED PEPTIDE IN A PROLONGED JAW OPENING MODEL. Cody Hyde, Jordan Hawkins, Biology. Faculty Advisor: Paul Durham

Temporomandibular joint disorders (TMDs), which is a chronic pain condition affecting > 15 million people, is characterized by peripheral and central sensitization of trigeminal nociceptive neurons. These disorders can be caused by trauma from routine visits to the general dentist or orthodontist. The pain and inflammation associated with TMDs are difficult to treat and there are currently no FDA approved drugs specific for TMD treatment. The goal of my study was to use a clinically relevant model of TMD and evaluate the therapeutic potential of a Calcitonin Gene-Related Peptide (CGRP) antagonist. Male Sprague-Dawley rats were used to investigate nocifensive behavioral responses to mechanical stimuli at 2, 24, and 72 hrs; and 7 and 14 days after prolonged near maximum jaw opening (20 mins). To test the effect of blocking CGRP binding, some animals were injected (i.t.) with the truncated form of CGRP ($CGRP_{8-37}$). No changes were observed in nocifensive behavior in control animals (naïve, isofluorane, intrathecal saline or $CGRP_{8-37}$). The increased nocifensive response to prolonged jaw opening was effectively blocked by pretreatment with $CGRP_{8-37}$ at all time points. Our findings show CGRP as an active participant in the pathology of TMD and future studies will identify its specific role.

#16 - EVALUATION OF COMMERCIAL SILVER-IMPREGNATED DRESSINGS TO INHIBIT GROWTH OF SILVER-RESISTANT BACTERIA ISOLATED FROM PATIENTS AT A LEVEL 1 TRAUMA CENTER. Shelby Harris, Rhy Norton, Paul L. Durham PhD, Biology, Research Advisor: Rhy Norton

Silver is an extremely effective antimicrobial agent. Hence, this property has caused a wide-spread integration of silver into commercial dressings. A recent collaboration with a level-1 trauma center resulted in the identification of two clinical bacterial isolates (*Klebsiella pneumoniae* and *Enterobacter cloacae*) that demonstrate unprecedented resistance to ionic silver. The purpose of my study was to determine if the silver resistant phenotype confers resistance to silver-impregnated dressings. Two different methods were used to gauge the effectiveness of commercially-available, silver-containing wound dressings against the two silver resistant microorganisms and a panel of silver-sensitive pathogens. In addition, the quantity and species of silver in each dressing related to bacteriocidal capabilities was compared. Overall, the silver-resistant species demonstrated an increased viability when in prolonged contact with all dressings, as compared to silver-sensitive control cultures. In addition, some of the dressings were more effective that others, despite lower quantities of total silver. Taken together, my results demonstrate that these microorganisms are resistant to silver at a level that could impact clinical practices and supports the notion that the species of silver is an important consideration in dressing selection. Thus, we advocate for the continued monitoring for silver resistance in the clinical setting.

#17 – AN EXAMINATION OF CONTAMINANTS OF EMERGING CONCERN IN THE OZARK WATERSHED REGION. Timothy J. Isakson and Alicia Kane, Chemistry. Faculty Advisor: Paul L. Durham.

Contaminants of emerging concern (CECs) are currently of particular interest to the scientific community because their environmental fate and potential effects to humans and wildlife are not well understood. These emerging contaminants are not strictly regulated, although some have shown potentially harmful effects to public health even at trace levels. Further research is needed to identify and quantify emerging contaminants in order to protect the rich aquatic heritage of the Ozark region as recreational activities in area lakes are a major source of tourism upon which the local economy is dependent. In my study, water samples were collected from various urban, agricultural, and rural locations throughout the southwest Missouri Ozark region. Target and non-target analyses were conducted on the samples using purge-and-trap methods in conjunction with gas chromatography-mass spectrometry (GC-MS). Solid phase and liquid-liquid extraction techniques will be employed for semi-volatile analytes in lieu of purge-and-trap techniques. Target analytes include estrogen disrupting compounds, pharmaceuticals, antibiotics, flame retardants, fragrances, and optical brighteners and will be updated based on the results of non-target analysis. The data will allow more informed decisions to be made in future water quality management decisions of the James River Basin and Table Rock Lake area.

#18 - INKJET-PRINTED MULTI SENSOR ARRAYS ON FLEXIBLE SUBSTRATES. Hillary Mitchell, Chemistry. Faculty Advisor: Adam Wanekaya.

This presentation describes the design, fabrication and analytical applications of flexible multi-sensor arrays. The sensor arrays were fabricated on flexible substrates using simple inkjet-printing technology. To achieve this, two types of nanoformulations were prepared: one formulation composed of conducting nanoparticle ink and the other composed of polymeric semiconducting nanoparticle ink. The polymeric and conducting inks were synthesized via chemical methods. Characterization of these inks was performed by cyclic voltammetry, Fourier-transformation infrared spectroscopy, UV-visible spectroscopy, Raman spectroscopy, and scanning electron microscopy. The sensor arrays were designed and printed such that the semi-conducting polymeric layer bridged the electrodes fabricated from the conducting nanoparticle ink. The polymer bridge layers acted as the sensing elements while the conducting ink layer acted as the electrodes as well as the interconnects for the circuits. Once the circuits were printed, they were imaged using SEM and conductivities measured. The sensor arrays were then employed for the detection of various analytes. The goal is to achieve reproducible, cost efficient, and flexible sensor array fabrication with the potential for mass production.

#19 - FECAL LOADING AND MICROBIAL SOURCE TRACKING OF SPRING WATER IN SPRINGFIELD AND GREENE COUNTY, MO. Solomiya Pshonyak, Kathryn Martin, and Kalie Somerville, Chemistry. Faculty Advisors: Paul Schweiger and Robert Pavlowsky

Spring discharges in areas of karst geology are important sources of water because they provide vital ecological services to receiving water and reflect the overall quality of the local drinking supply. Fecal waste enters karst systems from rural and urban run-off during rain events, and is especially high in agricultural areas due to manure application and livestock. Increased fecal waste in waterways may also be due to direct human influence (e.g. septic tank leaks, broken pipes, ineffective wastewater treatment, etc.). This fecal loading leads to eutrophication and increases the risk of enteric pathogen exposure in recreational waters and the drinking water supply. Practices can be implemented to mitigate waterway contamination if the source of fecal pollution is known. While coliforms have been classically used to monitor fecal loading in waterways, it is incapable of determining the source. In contrast, *Bacteroides* sp. have high host specificity and allows for species-specific tracking of fecal sources. The amount of fecal loading is currently being monitored in 10 springs and 4 surface water sites from the Sac River and James River Basins using a combination of IDEXX coliform detection and microbial source tracking using species-specific *Bacteroides* 16S rDNA markers for quantitative PCR.

#20 - INCREASING POOR SOLUBLE DRUGS USING SOLUPLUS®. Roni Balzam, Melinda Sutton, Frankie Weinberg, Chemistry. Faculty Advisor: Alan Schick

Most Active Pharmaceutical Ingredients (API's) have poor solubility in water. This research evaluates the solubility of a specific API, ibuprofen, in topical creams as enhanced by utilizing a solubilizing agent. The agent, known commercially as Soluplus®, is marketed by BASF Corp and is a triblock graft copolymer composed of poly(ethylene oxide) (PEO), poly(vinyl acetate) (PVA), and poly(Nvinylcaprolactam) (PVCA). It was originally developed to increase the solubility of poorly soluble drugs for oral applications. The hypothesis for this project is that Soluplus® will increase the solubility of the API's in topical gels and creams as it has for oral medications. To analyze the solubility, creams formulated with and without Soluplus® and ibuprofen were centrifuged at high velocities in order to separate the cream into its three phases—oil, solid, and aqueous. The liquid phases were quantified in terms of volume and analyzed for the presence of ibuprofen by using UV-Vis spectrophotometry. It is observed that Soluplus® has a dramatic effect on the relative amounts of oil vs. aqueous phases that separate out of the cream, as well as the partitioning of ibuprofen between the various phases of the formulations.

#21 - ROTENOID BIOSYNTHESIS: COMPUTATIONAL ANALYSIS OF COMPETING IONIC AND RADICAL PATHWAYS FOR CYCLIZATION. Adam Kirkpatrick, Chemistry. Faculty Advisor: Matthew Siebert.

Rotenoids are a naturally synthesized class of organic molecules, which are defined by a *cis*-fused tetrahydrochromeno-[3,4,b]-chromene nucleus. Commonly synthesized by the *Leguminosae* and *Nyctaginacae* families, this class of molecules has agricultural uses as an insecticide and piscicide, along with biological effects in mouse and human physiology. In this work, cyclization of the rotenoid B-ring was analyzed using DFT (B3LYP, M06-2X) and composite methods (G3) in gas- and (implicit) solution-phase. Assessment of the accuracy of these methods will be discussed. Two different mechanisms were analyzed: an ionic (carbocation) pathway described by heterolytic cleavage of a C-H bond, or a carbon radical pathway described by homolytic cleavage. Substituent effects on the rotenoid structure will be discussed. Calculations complete thus far indicate a thermodynamic preference for the formation of the radical intermediate under both of gas- and solution-phase conditions.

#22 - TABLE TOP POWER GRID DESIGN. Zach Abernathy, Logan Haden, Joseph Mbugua, and Kristi Weaver, Electrical Engineering. Faculty Advisor: Robert Egbert

Power is delivered and utilized in homes and businesses across the country through the electrical power grid. The electrical power grid consists of different tiers, which consist of power generation facilities, high voltage transmission lines, and low voltage distribution lines. Initially, power was generated and only distributed in a very limited area that was geographically close to the generator. Today, we have transmission lines that span across the United States and nearly the entire western civilization has access to power. Although electricity is available nearly everywhere, that may not always be the case. The grid is suffering from age and is not capable of providing all the power that is demanded. The power generation and transmission equipment is aging and does not perform as efficiently as it did originally. With an increased demand for generation all across the United States it is key for the future engineers to understand the design and implementation the standard power grid. This grid design project can give us insight into previous engineering and find solutions to improve the aging grid in an environmentally friendly and efficient manner.

#23 - DC TO AC SOURCE CONVERSION. Tyler Harris, Daniel Hill, Jesse Sherman, Electrical Engineering. Faculty Advisors Robert Egbert and Rohit Dua.

Due to the increasing availability and penetration of renewable energy generation technologies such as photovoltaic and DC wind turbines, smooth integration of DC sources into the AC grid is becoming increasingly important. This is an exercise to design and build a DC-AC inverter using a microcontroller, full-bridge and half-bridge inverters, phase sensing, and low-pass filtering circuits. The intent of the inverter is to be a working demonstration project that will allow future students to experiment and analyze the various stages for learning. It is meant as a proof of concept, meaning that the inverter will not be actually feeding power back into the grid or physically connected to it and will be able to power a small load. The rated power output has not yet been determined and will be based upon testing after building. Since it will be a learning tool, the multiple stages will be modular and will allow the connections between them to be changed quickly. This will enable students to see the effects of different switching and filtering schemes as well as different control strategies.

#24 - CONSTRUCTION OF GUIDED ROBOTS USING OFF-THE-SHELF MICROCONTROLLERS. Alan Tillekeratne, and Taylor Brooks, Electrical Engineering. Faculty Advisor: Robert Egbert.

Microcontrollers are often used in hobbyist robot projects. Because these projects are constructed by those with programming experience or knowledge of circuitry, but perhaps not both, a simple hobbyist robot will often be constructed with very specific components all meant to work together. By selecting components that were not specifically meant for this type of project, we had to research and assess the viability and operation of each component alone and in concert with other selected components. We used an 8-bit microcontroller to create a pair of robots. The two robots are identical in operation, but use slightly different forms of locomotion: one robot uses a pair of wheels and the other tank-like treads. An array of switches are used to input a sequence of moves. The robot then executes these moves by use of a low-power motor and optical encoders. If the robot comes into contact with an obstruction, a bump sensor activates an interrupt pin of the microcontroller and the sequence of moves is aborted.

#25 - OPERATING A 3 PHASE INDUCTION MOTOR FROM A SINGLE PHASE SUPPLY. Shane Jestus and Bryan Viles, Electrical Engineering, Faculty Advisor: Robert Egbert.

Three phase induction motors larger than 0.5 Hp are much less expensive than single phase motors of the same size. This is ok as long as three phase service is available in your area. Small rural shop owners have been experimenting for years on different techniques to use these cheaper three phase motors. This experiment was to efficiently operate a 3-phase induction motor from a single phase power supply. The basic design uses a capacitor, or a combination of a capacitor and resistor between two legs of a 3-phase induction motor. The capacitive circuit causes a phase delay, which allows the three phase induction motor to operate. We built 4 separate phase correction circuits using different combinations of a configuration called the "Steinmetz connection." Each circuit was tested for efficiency and compared to the other circuits. While the efficiency differed slightly with each of the correction circuits, all circuits operated the motor. Calculations for the size of capacitors and resistors depends on the size of the induction motor. A new correction circuit is needed for each motor size.

#26 – DEVELOPING A CURVE TRACER TO PLOT THE CHARACTERISTIC IV CURVES OF A THYRISTOR, BJT, MOSFET, AND DIODE. Larry Garringer, Benjamin Miller, Sean Starnes, Korey Holliday, Electrical Engineering. Faculty Advisor: Robert Egbert and Rohit Dua.

The Amplifier, Implementation Amplifier, Voltage Controlled Current Source (VCCS), and the Power Supply are the Peripherals designed for obtaining the characteristic I V curves for the Thyristor, BJT, MOSFET, and Diode. The Teensy 3.1 processes the signals for plotting the curves to the computer via Wifi connection. Software developed by our team will perform the math necessary to scale the axis, handle calculating early voltage, using cursors, and plotting.To graph the curves from our component the 2 Analog outputs from the Teensy will be amplified from 0-5V to ±8V. For the current controlled devices the amplifier output will be used to control the VCCS, and for Voltage controlled devices a relay will bypass the VCCS. The current output from this circuit will connect to the base leg of the transistor. The other Analog output will also pass through a second amplifier where the output is ±8V and this will control the Voltage across the collector and emitter terminals. The microcontroller's analog to digital converter will be used to measure voltage output from the Implementation Amplifier.

#27 – TESTING FOR METAL CONTAMINATION IN AURORA, MO. Amanda Bybee, Geography, Geology and Planning. Faculty Advisor: Melida Gutierrez

Aurora is a historic mining town in the Tri-state Mining District. Mining began in 1885 and ended by 1930. Mining waste (chat) remained in piles. Remediation started 2001 and continued through 2006. Metals (lead, zinc, cadmium) pose a risk to water quality. This study will use fluvial surface sediment samples to plot current conditions of metal contaminants in the area and their distribution using ArcMap, followed by comparing them with the location where chat piles used to be. The sediment dried, disaggregated and sieved to 1 mm. The samples were then analyzed for metals in a commercial lab. There are seventy-nine sediment samples with the following metal concentrations: cadmium ranged from 1.20 to 281.0 ppm with a median of 32.8 ppm, lead from 42.0 to 8200 ppm with a median of 196.0 ppm and zinc from 120.0 to 20400 ppm with a median of 3040 ppm. We compared sediment metal concentration data with stream sediment quality guidelines, to assess the health of the aquatic systems. Guidelines are 4.98, 128 and 458 ppm for cadmium, lead and zinc respectively. Our maps show the locations where the metal content exceeded these guidelines.

#28 – GEOCHEMICAL STUDY OF AL, CD, PB AND ZN FOUND IN CREEK SEDIMENT IN AURORA MISSOURI. Jameelah Rodriguez, Geography, Geology and Planning. Faculty Advisor: Melida Gutierrez

Historic mining companies in Aurora, Missouri, disposed of waste in chat piles that are no longer visible today. Samples of creek bed sediments were collected to evaluate the current impact of residual mining wastes. These benthic sediments were analyzed to determine the levels of lead, zinc, iron, aluminum and cadmium contamination. After drying, crushing, and sifting the collected material, each sample was sent to a commercial lab for testing. Samples were randomly selected for loss of ignition for carbonate content measuring, pH levels were also determined. The Munsell color system was used to document the different sample colors. High contamination levels were plotted on a map in an attempt to decipher a visible pattern in proximity to the old mining sites. The sediment samples were found to have elevated levels of lead, zinc, iron, aluminum and cadmium in areas that directly correlated in direct proximity to historic mining sites. Results of the analyses indicated that there are elevated levels of contamination that have a direct effect on the relationship to pH and organic matter content. The concentrations of Cd, Pb, and Zn pose a potential risk to the aquatic life in close proximity to the mining areas.

#29 - INFLUENCE OF RIPARIAN BUFFER WIDTH ON DISTURBANCE ZONE DISTRIBUTION IN BIG RIVER, MISSOURI. Thomas Pesek and Marc Owen, Geography, Geology and Planning. Faculty Advisor: Robert T. Pavlowsky.

Bank erosion is a leading cause of property damage, habitat loss, and sediment problems along rivers. Managers often plant trees to restore or maintain bank stability. However, it is common to see severe bank erosion along forested areas in some Ozarks rivers. To examine the role of forested buffer zones on bank erosion rates, this study compares average tree buffer widths along stable channel reaches and unstable, eroding channel reaches to test the hypothesis that the greatest erosion occurs along banks lacking forest cover. The study area is the Big River in the Ozarks Highlands region of Missouri. The methods for this study involve interpretation of aerial photographs using GIS. First, reaches of actively eroding channel were delineated. Second, forest buffer widths were measured at 100 m intervals and an average was found for each bank. Our hypothesis is supported if wide buffer widths tend to surround stable channels and narrow buffer widths surround disturbance zones. Recommendations will report critical buffer widths for bank protection and evaluate the effectiveness of riparian forests in controlling bank erosion.

#30 - MINING INFLUENCE ON LEAD PROFILES IN HISTORICAL FLOODPLAIN DEPOSITS ALONG THE BIG RIVER. Alison Keppel and Marc Owen, Ozarks Environmental and Water Resources Institute (OEWRI). Faculty Advisor: Robert Pavlowsky.

River floodplains function as sinks and sources of sediment in watersheds. In river systems affected by mining activities, floodplain soils can become contaminated with heavy metals by deposition and provide a long-term source of contamination as metal-rich sediment is released back to the channel by bank erosion. This study evaluates the concentration and spatial variability of floodplain contamination along Big River in southeast Missouri. The Big River drains the Old Lead Belt, a global leader in lead mining from 1900 to 1972. Sedimentological and geochemical analyses of floodplain deposits are used to demonstrate the long-term hazard of contamination in watersheds due to historical mining. A total of 18 cores were collected from a variety of floodplain elevations and ages of deposition ranging from 1 to 2 m deep. Concentrations of lead, zinc, inorganic/organic carbon, calcium and cesium-137 were used to determine stratigraphic relationships. The results reveal that floodplain deposits formed over the past 100 years are contaminated with lead concentrations >2,000 ppm. Lead concentrations in sediments deposited within the last 40 years have decreased to about 1,000 ppm after mine closure. Generally, Pb concentrations and depth of contamination decreases with elevation, lower flood frequency, and distance from the channel.

#31 – SPRING WATER ASSESSMENT NETWORK (SWAN), SPRINGFIELD AND GREENE COUNTY, MISSOURI. Tyler Beeman and Beau Brummel, Ozarks Environmental and Water Resources Institute (OEWRI). Faculty Advisor: Robert Pavlowsky.

Spring discharges are important sources of water in areas of karst geology because they provide important ecological services to receiving water and reflect the overall quality of the local drinking supply. Potential sources of pollution in karst systems in both the rural and urban environment include point sources such as wastewater treatment plant outfalls, industrial waste discharges, poorly functioning onsite wastewater systems, as well as nonpoint sources from urban development and agricultural activities. This study reports on the preliminary results of the Spring Water Assessment Network (SWAN) involving three departments and two centers in the College for Natural and Applied Sciences. A total of 10 springs and 4 surface water sites that represent different land use characteristics within the recharge area within Springfield and outlying areas of Greene County were sampled for a variety of physical properties, chemicals, nutrients, and bacteria. We are interpreting water quality trends by assessing the spatial and seasonal variability of water quality at base flow and evaluating potential causes of water quality variations. This is a joint project with the Ozarks Environmental and Water Resources Institute and Center for Biological and Life Sciences (CBLS) with help from Dr. Paul Schweiger (BIO), GGP, and CHM.

#32 - SPATIAL DISTRIBUTION AND CLASSIFICATION OF DISTURBANCE ZONES IN THE JAMES RIVER, SW MISSOURI. Joe Nash and Marc Owen Geography, Geology and Planning. Faculty Advisor: Robert Pavlowsky.

Land use changes within a watershed can cause geomorphic responses in rivers such as bank erosion, sediment aggradation, and channel migration. The James River in the Ozarks region of Southwest Missouri has been affected by past and present agricultural practices and urban developments. To evaluate how the James River has responded over time, aerial photographs from the 1950's, 1996 and 2008 were used to identify disturbance zones, or areas of significant channel change, along 157 km of the main channel for classification according to the four class system of Martin and Pavlowsky (2010). A total of 93 disturbance zones were identified including 59 megabars (63%), 17 extensions (18%), 14 translations (15%) and 3 cutoffs (3%). Forty-four percent of the disturbance zones are located in the 85 km downstream of Lake Springfield Dam, for an average of 0.48 disturbance zones per km, with 56% of the disturbance zones located upstream of Lake Springfield, for an average of 0.71 disturbance zones per km. These channel disturbance patterns are generally spatially-persistent over time and indicate the influence of both the natural controls of shallow bedrock and confined valleys on channel form as well as changes in flood regime and gravel sediment supply linked to human activities.

#33 - THE EFFECTS OF MICRO-INCLUSIONS ON INTERNAL STRUCTURE OF ZONED GARNET: AN EXAMPLE FROM THE TOCANTINS RHODOLITE GARNETS, TOCANTINS STATE, BRAZIL. Jeremiah Cousins, Michael Sholtis, and Don Hoover, Geography, Geology and Planning. Faculty Adviser: 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.

#34 - DESCRIPTION AND PRELIMINARY INTERPRETATION OF THE PRAIRIE CREEK DIATREME, CRATER OF DIAMONDS STATE PARK, ARKANSAS: A RE-EVALUATION OF THE VOLCANIC HISTORY FROM CORE ANALYSIS. Erica Gerweck, Geography, Geology and Planning. Faculty Advisor: Gary Michelfelder.

The Crater of Diamonds State Park located in Murfreesboro, Arkansas is known for its diamond bearing volcanic activity associate with the Cretaceous Prairie Creek Lamproite. Drill cores from the center of the park as well as the perimeter of the park provide clues to the extent of the volcanism of the region. Through description of two of these cores and interpretation of the core logs, we present a preliminary volcanic history of the Crater of Diamonds maar volcano. Two geologic units are present in the Crater of Diamonds maar which represents an explosive series and an intrusive series of magmatism. The intrusive series represents dikes, sills and possible lava flows of olivine-clinopyroxene lamproite. The lamproite contains small inclusions and xenoliths from the both the crust and the mantle. The explosive unit is classified as a pyroclastic lamproite and subdivided into a lapilli tuff and a breccia tuff. The lapilli tuff has been interpreted to be ash-fall, but we suggest this unit represents base surges associated with phreatomagmatic eruption. The breccia tuff is the diamond-bearing unit and has not been interpreted prior to this study. We suggest this unit represents pyroclastic density currents associated with the eruption of the maar.

#3 - GEOLOGY OF THE BLAKELY SANDSTONE, COLLIER, MAZARN AND WOMBLE SHALES. Cody Gibson and William "Bo" Masner, Geography, Geology and Planning. Faculty Advisor: Gary Michelfelder.

This project focuses on four units conformably bounding the Crystal Mountain Sandstone near Mt Ida, Arkansas. These three units are the Blakely Sandstone, the Collier Shale and the Womble Shale. The Blakely Shale member of the Blakely Sandstone is a middle Ordovician blue-gray shale with alternating layers of limestone and sandstone. The shale makes up between 50 and 75 percent of the unit and is ribboned. The Collier Shale crosses the Cambrian-Ordovician boundary. The dominant rock type is a dark gray to black shale with thin, very dense, extremely fractured bodies of chert. Womble shale is mostly black with alternating layers of limestone, silty sandstone, and occasional chert. Fossils are rare but trilobites and conodonts have been described. In some areas, the Mazarn is conformable the Crystal Mountain Sandstone, while in our area the Blakey Shale tops it. The Mazarn Shale is an early Ordovician shale with small amounts of siltstone, conglomeritic sandstone, limestone and black chert. The Womble Shale is Middle Ordivician in age and is the stratigraphically youngest sedimentary unit in the study area. The shales are black to green and are thin to laminate bedded. Cleavage, at an angle to bedding, frequently displays ribboned cleavage surfaces.

#36 - FLUID INCLUSION ANALYSIS OF MINERAL PHASES FROM THE BOLEO FORMATION, BAJA BASIN, BAJA MEXICO: A PROJECT IN PROGRESS AS PART OF THE NSF REU PROJECT FIELD-BASED RESEARCH ON THE GULF OF CALIFORNIA RIFT MARGIN BASINS, BAJA CALIFORNIA SUR, MÉXICO. Sam Reynolds and Ray Coveney, Geography, Geology and Planning. Faculty Advisor: Gary Michelfelder.

This project examines the petrogenesis of ore deposits and rocks of the Boleo Formation located in the Baja Basin of Mexico through field mapping, major and trace element geochemistry and fluid inclusion analysis of mineral phases. The work is part of a larger NSF funded REU project led by the University of Missouri at Kansas City. Here we discuss the goals of the REU project, current and future analytical work and preliminary results of fieldwork. The goals of this project are to determine the petrogensis of the basin and map out the location of potential ore deposits. Currently, fluid inclusion analyses of inclusions in gypsum are in progress at UMKC. We intend on determining the temperatures which the minerals associated with the ore are formed and the chemical conditions under which the fluids passed through the rock. This will be combined with whole rock major and trace element analyses to determine the source and composition of the fluids altering the Boleo Formation and depositing the ores. Currently, the area produces ore containing Cu, Co, Mn, and Zn.

#37 – TRACE ELEMENT VARIATION IN PHENOCRYSTS FROM IGNIMBRITES FROM THE MOGOLLON-DATIL VOLCANIC FIELD, SOUTHERN NEW MEXICO, USA: INSIGHTS INTO THE PROCESSES AND TIMESCALES OF MAGMATISM. Emily Salings, Geography, Geology and Planning. Faculty Advisor: Gary Michelfelder.

The Mogollon-Datil volcanic field in New Mexico represents the last volcanism associated with continental arc magmatism in the southwest United States. Here we present bulk-rock major- and trace- element compositions, Sr isotopic ratios and single crystal major- and trace- element data from two volcanic sequences near the Sierra Cuchillo Mountains. The Dacite-Rhyolite sequence (36.5 Ma) is a crystal-rich, high-K, calc-alkaline rhyolite consisting of six tuffs and tuff-breccias. The basal member is a densely welded, tuff-breccia and the remaining members are vitric-crystal tuffs. Phenocrysts include plagioclase> quartz>clinopyroxene>>hornblende. The youngest member also contains abundant sanidine. The Latite-Andesite sequence (36.2 Ma) is a crystal-rich, high-K, calc-alkaline suite of four volcanic units. The basal member consists of a crystal-rich, trachy-andesite lava. The remaining members of the sequence contain blocks of the underlying lava and lithics from the Paleozoic sedimentary rocks. Mineralogically, the tuff-breccia's contains plagioclase>alkali feldspar>quartz> biotite>hornblende>orthopyroxene. The lava flow contains plagioclase> clinopyroxene>alkali feldspar> hornblende>>quartz. Geochemically, the two volcanic sequences are distinct. Bulk-rock trace elements compositions for the dacite-rhyolite sequence exhibit pronounced negative Eu anomalies (Eu/Eu*~ 0.538) and high HREE concentrations (Lu=0.91 ppm, Yb=5.84 ppm). The latite-andesite sequences exhibits smaller Eu anomaly (Eu/Eu*=0.998) and comparatively lower HREE concentrations (Lu=0.24-0.27 ppm, Yb=1.5-1.7 ppm).

#38 - THE TRACE ELEMENT AND ISOTOPE GEOCHEMISTRY OF BASALTS ERUPTED IN THE MOGOLLON- DATIL VOLCANIC FIELD, NEW MEXICO. Eric R. Sikes and Emily Salings, Geography, Geology and Planning. Faculty Advisor: Gary Michelfelder.

Continental arc volcanoes represent a dramatic surface expression of one of the most significant and fundamental phenomena in global tectonics: the subduction of an oceanic plate beneath a more buoyant continental plate. The subduction of an oceanic plate results in recycling of crustal material into the convecting mantle, partial melting, and primary basalt production. Moreover, during passage through thick continental crust, subduction zone magmas may substantially differentiate and melt crustal rocks giving rise to the great diversity of igneous lithologies characteristic of earth. These are important processes that must be understood in detail in order to interpret the long-term evolution of the earth and continental crust. This project will investigate variations in the isotopic and trace element composition of basaltic lavas that are >20 million years old found in the Mogollon- Datil volcanic field (MDVF) of central New Mexico. Specifically, the aim is to determine the petrogenesis of poorly understood young volcanic rocks erupted from volcanoes in the MDVF, and use this information to shed light on how the continental crust influences trends in magma chemistry. This information in turn will be used to determine the condition under which the magma was accumulated and the processes occurring during accumulation.

#39 - WHAT GEOGRAPHIC FACTORS CONTRIBUTE TO GALICIA BECOMING AN IMPORTANT GEOTOURISM DESTINATION IN SPAIN? Layne Ivy, Geography, Geology and Planning. Faculty Advisor: Dr. Judith Meyer.

Geography is a critical factor of tourism development for any area. However, an increase in tourism is not always a positive experience for either the local, natural environment or the people living there. The objective of this research is to examine the main factors that make an area a tourist attraction and connect them with potential geotourism opportunities in Galicia, Spain. I used a comparative research method to compare opportunities in Galicia, Spain with other geotourism destinations in order to analyze Galicia's potential as a geotourism destination. Data shows that there are many beneficial geographic factors for such a small region: beaches, mountains, rivers and a climate different from the rest of Spain. With this in mind, geotourism opportunities associated with Galicia's unique geography, authentic culture, and family owned wineries are a few possibilities for the region. Tourism accounts for 10.6% of the total GDP in Galicia, which is one of the lowest of all non-industrial regions in Spain. One can conclude that Galicia has room to increase its tourism sector and, ultimately, help lower the unemployment rate of 21.07% while preserving their geography and culture

#40 – A POSSIBLE NEW SPECIES OF LATE JURASSIC RHYNCHONELLID FROM THE SUNDANCE FORMATION, FREMONT COUNTY, WYOMING. Laura E. Speir, Geography, Geology, and Planning. Faculty Advisor: Damon Bassett.

The Sundance Formation is exposed near Lander, Wyoming through the erosion of Laramide folds east of the Wind River Range. For over a century, these exposures have been used as a teaching tool for geology students learning to describe rocks in the field. During that time, the presence of brachiopods had been noted within the Jurassic age formation, but detailed descriptions and taxonomic identification have yet to be established. For this study, rhynchonellid brachiopods were collected from a stratigraphic section within the Sundance Formation. Internal and external descriptions were made in order to identify what may constitute a new species of rhynchonellid brachiopod. The external structures were described and cross referenced to classify the specimens to the genus level. Due to the limited number of specimens collected from the site, non-destructive techniques were used to further describe the brachiopods. Two initial specimens were scanned by Micro Photonics, Inc. using a micro CT scanner in order to determine the internal structures, which are necessary for classifying brachiopods at the species level.

#41 – ATLAS OF GEOLOGIC STRUCTURES OF GREENE COUNTY, MISSOURI IN LIDAR IMAGERY. Angie Miller, Geography, Geology and Planning. Faculty Advisor: Kevin Evans.

Dr. Ken Thomson began mapping the geology of Greene County in the 1970s and 1980s, and he compiled a bedrock geological map in 1986, where he showed the 17 geological structures known at the time. In this atlas, I used LiDAR data to construct a digital elevation model for the county in an effort to analyze those structures and additional structures that are noted in the Geological Survey of Missouri database, GeoStrat. In total, more than 43 different structural zones include over 100 different elements such as faults and folds. Together with the structures, an atlas was compiled using a geological overlay of the bedrock geology in ESRI ArcMap, and it also includes shapefiles for the roads, quadrangles, sinkholes, caves, springs, other hydrologic features, and elevation contours. Further analyses will include examination of the lengths of the faults, their directional orientations, and extensional or compressional nature. This will help scientists to better understand the geologic history and controls on karstification in southwestern Missouri.

#42 – DYNAMICS AND BIFURCATIONS OF A CHOLERA EPIDEMIOLOGY MODEL. Meagan Leppien and Mena Whalen, Mathematics. Faculty Advisor: Jorge Rebaza

A model of epidemiology that incorporates an environmental reservoir of *V. cholera* is studied. Previous results concerning local stability of the disease free equilibrium have been extended to include global stability analysis of such point, as well as existence and stability of an endemic equilibrium point. An appropriate Lyapunov function is constructed, and LaSalle invariance principle is used to prove global stability. Existence of a transcritical bifurcation of the model is also proved. Numerical calculations help illustrate the main results. One main difference between this and classical SIR and SIER models is that the dynamics of the bacteria is explicitly included in the model, which allows exploring the role of the aquatic reservoir on the persistence of endemic cholera. This presentation should be accessible to undergraduates with some linear algebra and introductory differential equations background.

#43 – COUNTING PERFECT MATCHINGS IN GRAPHS. Aaron Ogle, Mathematics**.** Faculty Advisor: Les Reid.

Given a graph $G = (V,E)$, a perfect matching is a subset of edges such that every vertex of the graph is incident to exactly one edge of the subset. This leads to the question, given a graph G, how many perfect matchings does it have? It has been shown that counting the number of perfect matchings in a general graph is #P complete. We will investigate this by looking at bipartite graphs, and different arrays of squares, cubes, and hypercubes. We will specifically look at $1 \times n$, $2 \times n$, and $3 \times n$ arrays of squares. As we count the number of perfect matchings we will look at what kind of sequences arise, and create recursive formulas to give us the number of perfect matchings in these graphs.

#44 - DOES LINEAR PRECISION SUFFICE. Meghan M. Burkhart, Electrical Engineering and Physics, Astronomy, and Materials Science. Advisor: Emmett Redd.

This attempt is the first known experimental effort to verify "Linear Precision Suffices" *, which is related to mathematical complexity theory. Using the program MATLAB, experiments were performed to test single and variable precision numerical data against the chaotic Hénon Map. True chaos never repeats, but digital models of chaos must repeat. Each individual precision has a unique repeat length due to the limited number of bits. The repeat length of each individual precision was found by running the iteration results through an auto correlation process. The parameters used for the Hénon Map were a=1.31 and b=0.3. After running many repeated trials of different precision, it was found that precision equal to or less than 4 digits had no effect on the repeat length and stayed a constant repeat length of 7 numerical data points. However, as precision increased past 4 digits, the repeat length of the numerical data increased faster than exponential.

*Siegelmann, H. T. (1999). Neural networks and analog computation: Beyond the turning limit. Boston, MA: Birkhäuser.

#45 – SEARCHING FOR NON-VARIABLE YELLOW SUPERGIANT STARS. Philip E. Crouse, Physics, Astronomy, and Materials Science. Faculty Advisor: Robert S. Patterson

From September to December 2014 a collection of yellow supergiant stars was observed with the 14-in. telescope and Apogee Alta u77 CCD camera at the Missouri State University Baker Observatory. Once the images were calibrated, the brightness of the program stars was obtained using differential aperture photometry. To be certain of any variability in program stars, double stars presumed to be constant in brightness of like spectral class, were observed concurrently. The Welch-Stetson was calculated for each star. A high Welch-Stetson index number indicates variability. HD 226095 was found to have a low amplitude variation. HD 190113, HD 186438, HD 22757, and HD 228808 were found to have no variation at the 1% precision level.