#1 - SUSCEPTIBILITY OF INVASIVE AQUATIC PLANTS TO AIR EXPOSURE DURING SIMULATED OVERLAND. Lindsey Bruckerhoff, Susan Knight, and John Havel. Faculty Advisor: John Havel.

The secondary spread of exotic macrophytes between lakes determines the scale of invasion and resulting ecological and economical impacts. Recreational boating is a vector for the overland transport of invasive species, especially macrophytes due to the tendency of fragments to become entangled on boats and trailers. The effectiveness of recreational boats as transport vectors relies on the resistance of macrophytes to air exposure. During the summer of 2011, we conducted four air tolerance field experiments in northern Wisconsin to determine how long Eurasian water-milfoil (Myriophyllum spicatum) and Curly-leaf pondweed (Potamogeton crispus) can survive out of water under conditions they would experience when ensnared on boats/trailers. We tested air tolerance by hanging macrophyte fragments to dry for different periods of time and assessing viability based on growth rates after rehydration. Eurasian Watermilfoil exhibited a positive growth rate after 24h of air exposure, while Curlyleaf Pondweed failed to grow after 12h of air exposure. The short air tolerance times exhibited in this study suggests that management and public education should focus most attention on boats moving within the scale of a few days.

#2 - INFLUENCE OF A SPRING ON FISH COMMUNITIES IN A SMALL OZARK STREAM. Myranda Clark, Biology. Hope Dodd, Heartland I&M Network, National Park Service. Faculty Advisor: Daniel Beckman.

It is a known fact that springs greatly influence the water temperature of the streams it encounters. However, little is known about the effects of spring-influenced streams on fish communities. In the spring, summer, fall and winter seasons of 2011, fish data, water quality and physical habitat were taken upstream and downstream of Double Spring, located on Terrell Creek within Wilson’s Creek National Battlefield, Missouri. We discovered temperature, dissolved oxygen and pH stayed consistent downstream of the spring, whereas temperature increased and dissolved oxygen decreased upstream until October when the upper reach was dry. In winter, readings leveled out to be consistent with spring. The fish community was quite different. In the lower portion, species richness ranged from 15 to 17 with richness and abundance increasing in summer and fall. The upper reach ranged from 10 to 12 species, decreasing in richness from spring to summer, but had a consistent abundance until October. As the upper reach began to dry and temperature of the water became warmer, abundance of cool water species declined. However, in the lower reach, both cool and warm water species were found. This data will improve our understanding of springs and their influence on aquatic communities.

#3 - HERITABILITY OF FLORAL TRAITS IN RUHELLA HUMILIS. LeAnn Hubbert, Joseph Michalski, Braden McCann; Biology. Faculty Advisor: John Heywood

Due to widespread habitat destruction, the Missouri native plant species *Ruellia humilis* has lost its hawkmoth pollinator. This has led to a significant increase in reproduction by self-pollination, and as a result, an increase in inbreeding depression. Consequently, the species may be experiencing strong selection for modifications to its reproductive strategy. In our greenhouse study, we determined the potential for adaptive evolutionary change in response to the loss of pollination services by hawkmoths. We estimated heritabilities of seven floral traits measured on flowers produced by 62 plants representing 10 families. Using analysis of variance, the variance of each floral trait was partitioned into several components, one of which is the variance in breeding values, which reflects the consistent effects of genes passed from parent to offspring. The heritability was estimated as the fraction of the total phenotypic variance that can be attributed to variation in breeding values. Correlations between estimated breeding values were calculated to generate genetic correlations between the seven measured traits. We found all traits to be significantly heritable. Statistically significant genetic correlations were also found between two pairs of traits. We conclude that the species demonstrates significant capacity for response to selection on its reproductive traits.
#4 - VPS1 LOCALIZES AT CELLULAR RECYCLING AND DEGRADATION CENTERS. Alexis Brummett, Hyoecun Ahn, Jacob Hayden, Joshua Lukehart, and Chad Highfill, Biology. Faculty Advisor: Kyoungtae Kim.

Protein’s function is tightly correlated with its localization. We recently have found that Vps1, a yeast GTP binding protein, plays important roles in endocytosis, recycling and endocytic degradation traffic pathways. Therefore, we hypothesized that Vps1 might be located at the site of endocytosis, the recycling center Golgi body, and the degradation compartments such as the endosome and the vacuole. To test the hypothesis we generated cells coexpressing a fluorophore-fused Vps1 and the specific fluorescent markers for endocytic site, Golgi, and endosomal compartments. Knowing the significance of the role of Vps1 in endocytosis, it is surprising to present here that Vps1 does not coincide with the endocytic site marked with Afp1, Sl1a1, and Edel. However, we found a higher level of colocalization between Vps1 and endosomal compartments, specifically with the later endosomal system. A lower, but yet significant level, of Vps1-Golgi colocalization was evident. Together, we conclude that Vps1 is bona fide component of recycling and endosomal centers. In the future, it is of interest to investigate the mechanism by which Vps1 is targeted to these different organelles.

#5 - ANALYZING THE EFFECTS OF BOAT TRAFFIC ON INJURY RATES IN FRESHWATER TURTLES IN NORTHERN OKLAHOMA. Ethan C. Hollender, and Travis L. Anthony, Biology. Faculty Advisor: Day Ligon.

Boat traffic has long been known to impact large marine animals such as manatees and sea turtles, but few studies have investigated the effects of recreational boat collisions on freshwater vertebrates. We compared injury rates in aquatic turtles across three rivers in northern Oklahoma. Specifically, we compared injury rates among different species and across two stream orders. 6.3% of all turtles trapped retained evidence of prior injury, and of the nine species studied, Trachemys scripta, Graptemys osachitensis, and Graptemys pseudogeographica accounted for 97.8% of injuries. Within these three species, we observed injury rates of 6.4%, 9.9%, and 9.8%, respectively. These data provide important information about the ways recreational boat use affects wildlife, but it should be noted that this study deals only with survivable injuries, and so may underestimate the actual effects. In 2012, we will also measure injury rates relative to the levels of boat traffic in each river and in relation to distance from boat ramps.

#6 - MINING HISTORY, SEDIMENT CONTAMINATION, AND ECOLOGICAL EFFECTS IN THE BIG RIVER, ST. FRANCOIS COUNTY, SE MISSOURI. Erin M. Murray, Biology. Faculty Advisor: Robert T. Pavlowsky, Geography, Geology, and Planning.

The Old Lead Belt is a historic Pb-Zn mining district within St. Francois County in Southeast Missouri that was a leading producer of lead worldwide from 1869 to 1972. Previous studies by government agencies have shown that channel sediments are contaminated with Pb and mussel and fish communities are impaired along the main stem of the Big River. The purpose of this study was to quantify the spatial trends of sediment contamination in the segment of the Big River most affected by mining inputs and to relate the trends to present-day Pb contamination sources and to toxic effects on aquatic life. Channel sediments (<2 mm fraction) were typically contaminated (>128 ppm Pb) with Pb concentrations greater than 2,000 ppm in the heart of the mining area from river km 160 to 140 in St. Francois County. Mining areas are presently inactive and all the large tailings piles have been contained. However, tributaries draining old mining sites are presently releasing Pb to the river from remobilized bed and bank deposits contaminated prior to Superfund mitigation. Almost all the channel sediment samples evaluated in this study were found to contain Pb concentrations that are potentially toxic to aquatic life.
#7 - OPTIMAL LEVEL OF PHOSPHATIDYLINOSITOL 4,5-BISPHOSPHATE IS REQUIRED FOR PROPER ORGANIZATION OF THE MEMBRANE COMPARTMENT EISOSOME. Sukje Lee, Erin Murphy, Brandon Tenay, Joshua Fakilahyel, and Evin Kimberlin, Biology. Faculty Advisor: Kyoungtae Kim.

The eisosome is an immobile protein complex that lies under the plasma membrane in yeast. Pif1 is the chief protein that participates in eisosome organization and is required for the stability of the eisosome organization. The eisosome is physically associated with the membrane compartment containing Can1 (MCC), which is composed of higher levels of phospholipids, sphingolipids, and cholesterol. Membrane rafts in mammalian cells have a structure similar to the MCC in yeast, and defects in cholesterol and phospholipids synthesis affect membrane rafts in mammalian cells. Our group tested the tentative role of cholesterol and phospholipids on eisosome organization by quantitating the effect of the loss of genes involved in cholesterol synthesis (ERG3, ERG4, ERG6, and ERG24) and PIP2 synthesis (SIL1, SIL2, and SIL3) on eisosome organization. It was evident that optimal levels of phospholipids, but not ergosterol, are required for proper eisosome organization. In addition, we present here the spatial relationship of the eisosome with MCT (membrane compartment containing Tor2), MCC, and pinocytic and receptor mediated endocytic sites.

#8 - METABOLIC DIFFERENCES AMONG CLUTCHES FOR NEWLY HATCHED SPOTTED SALAMANDERS. Valerie Jones, Adam Crane and Alicia Mathis, Biology. Faculty Advisor: Alicia Mathis.

For animals in variable or unpredictable environments, individuals often exhibit a diversity of phenotypes. Many amphibians lay their eggs in vernal pools which are highly variable spatially and temporally. In ambystomatid salamanders, clutch differences in some morphological characteristics have been reported, but no studies have looked for metabolic differences among clutches. We raised eggs from spotted salamanders (Ambystoma maculatum) from six clutches in the laboratory, with eggs from each clutch kept together. Within 24 hours after hatching, we quantified heart rates of larvae by observing them under a dissecting microscope. There was a significant difference in heart rates among clutches. These differences could have been due to subtle differences in rearing environments between the clutches or to genetic differences.

#9 - CGRP, VIP, AND NPY IN SALIVA AND SERUM OF PEDIATRIC CANCER PATIENTS: POTENTIAL FOR DISEASES MARKERS Evan Clark, Carrie Vause, Paul L. Durham, Biology. Faculty Advisor: Paul Durham.

Calcitonin gene-related peptide (CGRP), vasoactive intestinal peptide (VIP), and neuropeptide Y (NPY) are present in saliva of patients with inflammatory disorders, and thus, may be useful as biomarkers of progression or treatment response. Typically, disease progression is monitored by measuring changes in proteins contained in serum. We hypothesized that saliva could be used as a prognostic tool instead of serum in pediatric cancer patients. To test my hypothesis, serum and saliva samples were obtained from 16 pediatric cancer patients (7 female and 9 males, age range of 9-17 years) at the University of Utah and each sample analyzed for the level of CGRP, NPY, and VIP peptides by radioimmunoassay. Saliva levels were at least 10-fold lower than serum for CGRP and NPY after they were normalized to total protein and volume. VIP levels were similar in serum and saliva. The highest saliva peptide levels were found in medulloblastoma and Hodgkin’s disease while the highest levels of serum proteins were found in blood related cancers like lymphoma or leukemia. Data from this small pilot study support conducting a larger study to validate the usefulness of measuring peptides levels in saliva as a complementary means to monitor treatment response and disease progression.
#10 – TOR PROTEIN KINASES AFFECT RECRUITMENTS OF ENDOCYTIC PROTEINS AND ENDOCYTIC SCISSION EFFICIENCY. Kimberlin Evin, Brandon Tenay, and Fakilahyel Josh, Biology. Faculty Advisor: Kim Kyoungtae

Tor2 protein kinase is a component of the TORC2 complex that plays a role in actin organization and cell growth. Since actin defects are correlated with endocytic defects, we hypothesized that Tor proteins play roles in endocytosis. We examined the effects of loss of tor protein kinase activities on two types of yeast endocytosis: liquid-phase and receptor-mediated endocytosis. We found that liquid-phase endocytosis from the membrane to the vacuole was not affected in tor mutants. However, during receptor-mediated endocytosis scission failure rate was significantly increased in all tor mutant cells, with tor1Δtor2ts mutant having the severest scission defect. Furthermore, we found severe mistargeting of the endocytic protein Rvs167 to the cytoplasm as well as SjI2 in tor1Δtor2ts mutant cell. Since the aberrant targeting of Rvs167 and SjI2 is reminiscent of the phenotypic defect found in Pih1-deficient cells, we examined whether the localization of Pih1 is disrupted in tor mutant cells. As expected, there was a severe defect in Pih1 localization in tor1Δtor2ts cell, as well as Nce102. All together, our results point to Tor proteins playing important roles both in recruiting of the scission protein Rvs167 to sites of endocytosis and localization of Pih1 to the periphery of the plasma membrane.

#11 – MARINE FISH AND HABITAT STATUS IN BLUEFIELDS BAY SANCTUARY, JAMAICA. Aaron Pavlowsky, Biology. Faculty Advisor: Daniel W. Beckman

Marine life in Jamaica has degraded due to overfishing, water pollution, sedimentation, and climate change. To partially address this problem, nine sanctuaries were created to provide protected areas for fish. In 2009, the Bluefields Bay sanctuary was formed on the southwest coast of Jamaica, covering an area of 15 km². The first step was to evaluate the present condition of the bay and develop a management plan. However, the local fishing and farming community lacks the resources and expertise required to complete these studies. The Missouri State University departments of Biology and Geography, Geology, and Planning are now working in partnership with local communities to complete the baseline assessment. MSU’s objectives are to collect and evaluate data on the present condition of fish, coral and bottom substrate, and shoreline erosion in Bluefields Bay. An underwater camera is used to assess marine life. Visual surveys and satellite imagery will be used to determine coral reef and bottom substrate characteristics. The shoreline will be mapped using a GPS-camera and sonar depth mapping. This poster reports the preliminary results of the baseline assessment. The MSU assessment team will return to Jamaica in May 2012 to complete the survey.

#12 – EVALUATING DIVERSITY, ABUNDANCE, AND TOXIN POTENTIAL OF ALGAE IN MISSOURI RESERVOIRS. Lauren Bansbach, Biology. Faculty Advisors: John Havel and Russell Rhodes.

Algae are important in lakes both as primary producers and for impacts on water quality. In drinking water reservoirs, some algae cause nuisance taste and odor problems and some create harmful toxins. The prediction of algal blooms and when algae release toxins is not well understood. I examined algal community structure in two Missouri reservoirs in September 2011. McDannel Lake in Greene Co. (area of 1.12km², mean depth of 4.9m) is a drinking water source for Springfield with a history of taste and odor problems. Bull Shoals Lake in Taney Co. (area of 182.7km², mean depth of 23m) is a large reservoir built for flood control and power generation. I assessed vertical segregation of algae by identifying and counting algae from three depths (at the surface, above the thermocline, and below the thermocline) for each reservoir. I identified a total of 54 genera. McDannel Lake (47 genera) exhibited higher diversity overall than Bull Shoals Lake (31 genera). Although neither reservoir has documented problems with algae toxins, I identified at least 6 genera that are capable of producing toxins in each lake (e.g. Anabaena, Microcystis, and Oscillatoria). Two of these potential toxin producers represented the most abundant genera among both lakes.
The rock grape (*Vitis rupestris* Scheele), once common from the East Coast to Texas, grows in genetically diverse populations only in the Ozarks. This species had a major contribution to the world of agriculture by serving as a genetic resource for grape breeding during the past 130 years. This project is designed to examine the nature of disease resistance in native populations of rock grape in the Missouri Ozarks. We will constructing F1 hybrid progeny from a cross between rock grape accessions and a disease-susceptible cultivated grapevine, and examine the segregation of plant defense traits. It has recently been shown that as grape breeders developed downy mildew (*Plasmopara viticola*) resistant hybrid varieties during the past century, they were selecting for the *Rpv3* locus from *V. rupestris*. *Rpv3* is the major determinant factor of downy mildew resistance in grapevine. Interestingly, most hybrid grapes around the world contain *Rpv3* DNA from rock grape accessions native to the Ozarks, demonstrating the enormous value of our local plants. As today’s grape breeders strive to reduce chemical disease control and rely instead on the innate disease resistance of the grapevines, the value of Missouri’s rock grape as a source of resistance is greater than ever.

Migraine is a painful, neurovascular disease that is prevalent in both men and women with an annual cost to healthcare and employment productivity near $17 billion. Triptans are a class of drugs commonly prescribed for migraines. Clinical observations indicate chronic smokers do not respond to triptans. Our goal was to study the molecular mechanisms of nicotine and sumatriptan in an acute migraine model by measuring changes in inflammatory proteins. Nicotine was administered via osmotic pump to male Sprague-Dawley rats for 14 days. Some animals were injected with 1 μM capsaicin 14 days post-implant. Another set was treated immediately after capsaicin injections with sumatriptan. Trigeminal ganglia and upper spinal cord tissues were harvested 2 hours after capsaicin injections and used for cytokine array and immunohistochemical analysis. We found that chronic levels of nicotine equivalent to amounts in moderate to heavy smokers caused an upregulation of inflammatory signaling proteins and cytokines. Importantly, sumatriptan did not significantly suppress protein upregulation as a result of chronic nicotine. Results from this study provide a plausible explanation for why chronic smokers do not usually benefit from sumatriptan treatment since the stimulatory effects of nicotine on trigeminal nerves was not blocked by this commonly prescribed abortive anti-migraine drug.

OnabotulinumtoxinA was recently approved as a treatment for chronic migraine and is thought to block the release of CGRP, a potent neuropeptide implicated in orofacial pain. Recent studies have demonstrated that salivary CGRP levels are elevated during the attack phase of episodic migraine and correlate with treatment response in a majority of migraineurs. The objective of this study was to determine whether saliva levels of CGRP correlate with response to onabotulinumtoxinA treatment in chronic migraine patients. Twenty subjects were treated with OnabotulinumtoxinA and placebo (saline) over a seven month period in a randomized, crossover, parallel group study. Saliva was collected and CGRP levels measured using a specific radioimmunoassay and then normalized to total protein and volume. CGRP levels, pain levels, and the number of headache days per month were compared for onabotulinumtoxinA and placebo patients. CGRP levels did not increase during migraine attack phase for any group. Importantly, subjects experiencing at least 30% reduction of migraine frequency following onabotulinumtoxinA also experienced a statistically superior response to acute treatment. In contrast to previous findings with episodic migraine, CGRP levels did not correlate to migraine attack or treatment response. However, individuals who responded to onabotulinumtoxinA had a superior response to acute therapy.

The hypothalamic neuropeptides called orexins are thought to be key in regulating sleep and orexin antagonists have shown promise restoring sleep architecture, particularly in sleep disorders. Clinical data indicates a significant link between sleep quality and migraine, a neurological disorder that involves activation of the trigeminal nerve. Moreover, sleep is known to be an effective migraine treatment. Nevertheless, the roles of orexins and their antagonists in chronic inflammation are not well understood. Our hypothesis was that administration of Dual Orexin Receptor Antagonist 10 (DORA-10) would block the transition from acute to chronic pain in response to inflammatory stimuli and prevent trigeminal sensitization during REM sleep deprivation by restoring normal sleep architecture. Results from our study demonstrate that levels of the inflammatory markers P-ERK, P-p38, and Iba1 were decreased with DORA-10 compared to animals injected with complete Freund's adjuvant, a compound known to induce chronic inflammation. Furthermore, the thermal sensitization caused by three days of REM sleep deprivation was attenuated by DORA-10. Based on my results, I propose that DORA-10 should be an effective therapy to reduce neuronal and glial activation under inflammatory conditions and during REM sleep deprivation.


Calcitonin gene-related peptide (CGRP) is a 37 amino acid neuropeptide that promotes inflammation and nociception. CGRP, which is made in neuronal cell bodies located in trigeminal and dorsal root ganglia, is released in the spinal cord following tissue injury. I hypothesized that CGRP expression would be greatest in the cervical region of the spinal cord and by more prevalent in trigeminal ganglia than dorsal root ganglia. After perfusion of Sprague-Dawley rats with fixative, the spinal cord with attached DRGs was dissected from the C1 to L5 and sucrose fixed to prevent freeze fracture of tissues. In addition trigeminal ganglia were obtained. Tissues were cryosectioned at 14 μm and prepared for immunohistochemistry with primary antibodies against CGRP. Images were obtained with a fluorescent microscope and organized for comparative analysis with ImageJ software. Higher expression of CGRP were found in tissues toward the cervical region of the spinal column compared to tissues in the lumbar region. In conclusion, my results provide evidence that CGRP is preferentially expressed in trigeminal ganglia and upper spinal cord. Thus, CGRP is likely to play a more important role in the underlying pathology of diseases involving activation of trigeminal nerves and the subsequent release of CGRP.

#18 - EFFECT OF DIET ON BODY SIZE AND AGGRESSION OF RING SALAMANDER LARVAE. Courtney Heuring and Whitney Heuring, Biology. Faculty Advisor: Alicia Mathis.

The diet of individuals can affect both their body condition and behavior. Using larval ringed salamanders (Ambystoma annulatum), we tested the effects of high-quality and low-quality diets. The larval salamanders were divided into two groups: residents and intruders. Half of the residents were fed a high-quality diet and half were fed a low-quality diet, while the intruders were all fed a high-quality diet. For each trial, an intruder was placed into resident's chamber and aggression between the salamanders was recorded before and after introduction of food. The number of visits to a feeding dish was also monitored during this time. In the absence of food, high-fed residents were significantly more aggressive than low-fed residents. There was low aggression by the intruders towards residents of both diets. In the presence of food, residents of both diets were equally aggressive, while intruders paired with low-fed residents were more aggressive than intruders paired with high-fed residents. Also, low-fed residents visited the feeding dish more than high-fed residents in the presence of food.
#19 - BEHAVIORAL AND METABOLIC RESPONSES OF OZARK ZIGZAG SALAMANDERS TO ALARM/STRESS SECRETIONS FROM PREY GUILD MEMBERS. Michael Lampe, Adam Crane and Alicia Mathis, Biology. Advisor: Alicia Mathis.

When different species have common predators, selection should favor individuals that respond to alarm cues of the other species. Ozark zigzag salamanders (Plethodon angusticlavius) are often found under rocks and logs during wet conditions, but they also use subterranean burrows during harsh environmental periods. These salamanders can assess chemical cues in their environment, including cues from predators and alarm/stress cues from conspecifics. Earthworms (Lumbricus terrestris) are abundant, syntopic and are vulnerable to the same predators as the salamanders. We tested whether salamanders would respond to alarm/stress cues from earthworms in ways that are consistent with antipredator behavior. We obtained alarm/stress cues from earthworms by simulating a predatory attack (grasping them with forceps) and collecting the secretions in water. Salamanders significantly increased their time spent in escape behavior, decreased their chemosensory behavior, and increased oxygen consumption when exposed to stressed earthworm cues, whereas their responses to cues from unstressed earthworms were similar to responses to blank water. These results suggest that salamanders can recognize alarm/stress cues from earthworms as dangerous.

#20 - TUMOR NECROSIS FACTOR ALPHA REGULATES CYTOKINE EXPRESSION IN TRIGEMINAL GANGLIA AND SPINAL TRIGEMINAL NUCLEUS IN A MODEL OF TMJ PATHOLOGY Zachary Durham, Joseph Glenn, and Paul L. Durham, Biology. Faculty Advisor: Paul L. Durham

Elevated levels of the cytokine tumor necrosis factor-α (TNFα) in the capsule of the temporomandibular joint (TMJ, jaw joint) are known to promote inflammation and pain. Trigeminal ganglia nerves provide sensory innervation to the TMJ and thus function to facilitate pain transmission from the capsule to the central nervous system. I hypothesized that elevated levels of TNFα in the TMJ capsule would cause changes in the expression of other pro-inflammatory cytokines in the trigeminal ganglia and spinal trigeminal nucleus. Male Sprague-Dawley rats were injected in the TMJ capsule with 100 ng/ml of TNFα, 1 μM of the noxious stimulus capsaicin, or in combination in the capsule. Tissues were collected and the levels of 29 cytokines measured using a commercially available cytokine array. Short-term treatment with TNFα alone did not have a significant effect on cytokine levels. However, cytokine levels were significantly changed in animals treated with TNFα and capsaicin. Based on my findings, I propose that TNFα plays an important in the pathology of TMJ pathology by modulating the expression of cytokines in trigeminal ganglia and spinal trigeminal nucleus.

#21 - INVESTIGATION OF LOCAL DYNAMICS OF DAMAGED DNA BY ANALYSIS OF DEUTERIUM LABELED NUCLEOSIDES WITH SOLID STATE NUCLEAR MAGNETIC RESONANCE AND RAMAN SPECTROSCOPY. Aaron Proctor and Heather Osswald, Chemistry. Faculty Advisor: Gary Meints.

A primary tool used by DNA to repair damage is the base excision repair (BER) process. What initiates this process is not fully understood. We are synthesizing deuterium labeled nucleosides, incorporating them into a well-known DNA sequence (the Dickerson strand), and conducting comparative solid state NMR and Raman analysis of damaged and healthy DNA. The NMR analysis will give us information about the local flexibility and thermodynamic stability of these labeled sites. The Raman analysis will yield vibrational mode and bonding information. Currently, we are labeling the 3′ position of the thymidine nucleoside via a stereospecific reduction. After purification by column chromatography the labeled nucleoside is protected, phosphitylated, and synthesized into DNA. We are also converting a 5′ labeled adenosine nucleoside (previously labeled) into a damaged form – etheno deoxyadenosine. Data collected for these compounds should provide insight into whether these lesions cause changes in local dynamics of DNA, and if these changes could prompt the BER process.
#22 - CHARACTERIZING HELICAL DISTORTIONS IN DNA WITH SINGLE-BASE LESIONS.
Christopher M. Reynolds, Faculty Advisor: Gary Meints

Circular Dichroism (CD) spectroscopy was performed on the Dickerson oligomeric dsDNA sequence (CGCGAATTCGCG; Dickerson, et al) for samples at (1) varying concentration and (2) varying temperatures to observe the effects of such conditions on its helicity. These observations were then compared to the CD signatures of oligomers with single-base lesions such as 1,N6-ethenoadenine. Results from this work imply an aspect of damage recognition by repair enzymes would be exhibited in the CD spectrum.

#23 - SYNTHESIS AND CHARACTERIZATION OF TWO SUBSTITUTED ACETONITRILES – PRECURSOR FOR CYANOXIMES THAT FORM LIGHT-INSERITIVE AG(I) COMPLEXES.
Courtney Riddles and Nikolay Gerasimchuk, Chemistry. Faculty Advisor: Nikolay Gerasimchuk

The reaction between neat the secondary amines N-piperidine and morpholine with cyanacetic esters in the absence of any solvents leads to substituted acetonitriles NC-CH2-C(O)-N(CH2)2X in high yield (X = CH2 for piperidine, X = O for morpholine). These substituted acetonitriles were then converted into their respective cyanoximes, HPCO and HMCO, using gaseous methylnitrite CH3-ONO at ambient conditions. Deprotonation of these cyanoximes with KOH in aqueous solutions with subsequent addition of AgNO3 affords thick, yellow precipitates of AgL (L = PCO, and MCO anions), which were characterized via elemental analyses and IR spectroscopy. Both Ag(I) complexes are planned for studies of resistance towards an intense visible light (400 nm) and UV-light (256 nm) with intent to use them as light-stable antimicrobial additives to light-curable acrylate-based adhesives and composites used during introduction of indwelling medical devices and dental implants. These compounds must similarly be UV-resistant during the adhesive process so that they do not degrade and their antimicrobial properties are retained once inserted into the body.

#24 - SYNTHESIS OF 1-ETHYNYL-2-NITRO-4,5-DIALKOXYBENZENES
Shalisa Oburn, Chemistry. Faculty Advisor: Eric Bosch

Organic compounds containing an ethynyl and nitro substituent should experience intermolecular hydrogen bonding in the solid state between the partially positive charged ethynyl hydrogen and negatively charged oxygen of the nitro substituent. For 1-ethynyl-2-nitro-4,5-dialkoxybenzenes, intermolecular hydrogen bonding can be assessed in the crystal structure using x-ray crystallography. Intermolecular hydrogen bonding has been observed for pentane and methane R group compounds in the solid crystal structure, confirmed via x-ray crystallography. Research is focused on synthesis of other alkane R group compounds for confirmation of intermolecular hydrogen bonding.
#25 - SYNTHESIS OF TUNGSTEN TRIOXIDE AND THE EFFECTS OF SIZE AND SHAPE ON ELECTROCHROMISM Brett Huntley, Chemistry. Faculty Advisor: Alan Schick

Tungsten trioxide is an electrochromic material that in recent years has been employed in new technologies such as smart glass and electrochromic windows. In this research we are analyzing the effects of particle size and shape on the electrochromic properties of the tungsten oxide. We synthesize tungsten trioxide by sol-gel methods, which can yield a variety of particle sizes and shapes, depending on processing parameters. In this study, SEM imaging and spectroscopic analysis are used to characterize the effects of precursor concentration and post-processing additives on the resulting particle structure and morphology. This work currently focuses on particles in the size range of 100 to 10000 nm that are produced from the polycondensation of tungstic acid in aqueous solution. The effects of hydrogen-bonding surfactants, tungstic acid concentrations, and reaction pH on particle structure are described, and the results are discussed in terms of applications in device construction.

#26 - SIMULTANEOUS SIMPLEX AND GENETIC ALGORITHM OPTIMIZATION OF INTRAMOLECULAR PARAMETERS FOR AROMATIC MOLECULES IN THE AMBER FORCE FIELD. Anneli Hoggard, Chemistry. Faculty Advisor: Dean Cuebas.

Modeling of molecular dynamics using force fields offers an efficient alternative to ab initio methods. In force field modeling, intramolecular terms are modeled as harmonic springs and are assigned empirical force constants. Traditionally, bond/angle/torsional force constants are generalized for given atom types; force fields tend to err on the side of under-fitting as to not limit transferability. This approach, although largely effective, misrepresents certain bond types. We have modified Amber force field parameters for benzene, a model aromatic compound. This was accomplished by generation of various benzene structures by random displacement along all of its normal modes. These structures were utilized to simultaneously refit bond lengths/angle/torsions and all associated force constants using simplex and genetic minimization algorithms to best fit force field calculated energies to quantum mechanical energies at the MP2/6-311+G(2d,p) level. Structures from a sample trajectory were sampled and utilized in the same method to further refine calculated parameters. We found a significant improvement with these optimized parameters as compared to standard Amber parameters. Additionally, parameter adjustment affects bulk modeling of benzene, which may increase the accuracy of modeled benzene solutions. In the future, this method will be applied to other important aromatics (nucleotide bases) for enhanced modeling capabilities.

#27 - DESIGN AND FABRICATION OF CIVIL ENGINEERING FLUME DEVICE MEASUREMENT SYSTEM. Nathan Jester, Jacob Fuchs, Jon Boessen, Vishal Ganda, Electrical Engineering. Faculty Advisor: Bob Egbert.

The Civil Engineering water laboratory is a valuable asset for teaching in the Civil Engineering department. The Electrical Engineering department is adding instrumentation to two water flow simulation machines. Team Alpha is working on a Water Flume machine which simulates the behavior of water flow in a flume, dam, or river. Instrumentation is required to measure the flume angle, pump motor power, and piping system water flow. The measurements are captured by a two Differential Pressure Transducers, a 3-Phase Power Meter, & a ±30° Inclinometer, processed by a Programmable Logic Controller, and displayed in real time on a touch-screen. All wiring, sensors, electronic devices, etc. are housed in an industrial safety standard enclosures, powered by and protected by an independent power supply with appropriate protective equipment. The project required extensive knowledge in many aspects of Electrical Engineering, including System Controls, Electronics, and Power, in addition to an understanding of the appropriate aspects of Civil Engineering. The Civil Engineering aspects have been advised by Dr. Pierson, who also teaches the labs using the machines. The tasks required to complete the project include extensive research on device ratings and specifications, hands-on experience, organization and tasking, and a thorough engineering background.
#28 - PIPE MEASUREMENT SYSTEM FOR PRESSURE, FLOW, POWER AND EFFICIENCY IN PIPE NETWORK FOR WATER RESOURCES LABORATORY. Scott Austin, Zach Engleman, Seth Bade, Philip Hubbert, Electrical Engineering. Faculty Advisor: Robert Egbert.

The civil engineering department, in the Kemper Hall requires instrumentation for a pipe network to verify results calculated through the course of the water resources laboratory. The pipe network simulates a city water system for the civil engineering students to demonstrate the variation in flow and pressure with regards to pipe diameter and valve positions. With the application of a wattmeter, pressure transducers, and Bernoulli’s equations, students obtain data to describe the input power, output power, and efficiency of the pump motor into a Vision 350 Programmable Logic Controller (PLC). The students input the pipe diameters and the coefficients of discharge across the orifice and venturi connections into a PLC for a precise, user-friendly interface for students. The PLC uses Bernoulli’s equations and the input power to the motor, the output power from the motor, and the flow rate of the system. The interface will be an aid for experiments in the future.

#29 – COMPARISON OF RADON-222 CONCENTRATIONS IN HOUSES AND THE ROCKS-SOILS THEY ARE BUILT ON USING THE PRO-3 DIGITAL RADON DETECTOR. Sara Cheek, David Brannan, Geography, Geology and Planning. Faculty Advisor: Erwin Mantei.

The Surgeon General has declared that radon gas is the second leading cause of lung cancer in humans. Concentrations of Radon-222 in the Chattanooga Shale rock-soils and houses in southwest Missouri will be determined. The PRO-3 Digital Radon Detector has been approved by the Environmental Protection Agency for dependable results of Radon concentrations. The detector converts pulse volume into Rn-222 concentrations in picocuries per liter. Rock and soil samples will be crushed or disaggregated using a mortar and pestle and sieved in the lab. An allotted portion of each sample will be placed in an fish aquarium with the detector for 30 days to attain secular equilibrium and the concentrations of Rn-222 determined. A detector will be placed in each house to determine the same. Comparisons of Rn-222 concentrations from the natural materials with that in the houses will be made. Rn-222 differences may result from attenuation factors such as the impermeability of the foundation material of the house or higher concentrations resulting from other emissions of Rn-222 in the house.

#30 - PHYSICAL DEFORMATION AND CHEMICAL ALTERATION IN PRECAMBRIAN BASEMENT GRANITE, SOUTHWESTERN MISSOURI. Ashley C. Dameron, Thomas G. Plymate, Geography, Geology and Planning. Faculty Advisor: Dr. Thomas Plymate

An exploratory well drilled in southwest Missouri offers an interesting look at both physical deformation and chemical alteration of the uppermost ten feet of the granitic basement of the Mesoproterozoic Southern Granite-Rhyolite Province. Our petrographic analysis is based on four thin sections at approximately two foot intervals, with the first sample taken from 2147.2 feet below the surface. Structural deformation is indicated by the presence of faults and folds in mineral grains within each sample. Microfaults are visible within K-feldspar crystals, while folding and shearing is evident in some muscovite grains. Each of the four samples displays chemical alteration from fluid interaction. This alteration is referred to as epidotization, where the mineral epidote replaces plagioclase crystals. These veins of epidote align preferentially along albite stringers in K-feldspar crystals. Secondary calcite alteration is also visible within the epidote alteration. Our analysis indicates that there have been multiple stages of both physical deformation and chemical alteration within the granite. The samples for this study came from an exploratory well drilled with the financial support of the Department of Energy National Energy Technology Laboratory under Award Number DE-NT0006642 to City Utilities of Springfield, MO.
#31 - PROPERTIES OF FIRST-DEGREE SYSTEMS WITH COEFFICIENTS IN ARITHMETIC, POLYNOMIAL, AND GEOMETRIC SEQUENCE. Gerhardt Hinkle, Central High School, Mathematics. Faculty Advisor: Les Reid.

A recent International Baccalaureate Higher Level Mathematics Internal Assessment posed a problem concerning the solutions to two and three variable equations with coefficients in arithmetic sequence and two variable equations with coefficients in geometric sequence. This paper generalizes the result of that investigation to the greatest possible extent that can still yield meaningful results. It derives nontrivial, general solutions by writing the equations in summation notation as $\sum_{i=0}^{n-1} (a + id)x_i = a + nd$ (arithmetic sequences); $\sum_{i=0}^{n-1} p(i)x_i = p(n)$, where $p(i) = \sum_{j=0}^{d} a_j i^j$ (polynomial sequences, a further extension of arithmetic sequences); and $\sum_{i=0}^{n-1} r^i x_i = r^n$ (geometric sequences).

#32 - CCD PHOTOMETRY OF YELLOW SUPERGIANT STARS. Henry Stratmann, Physics, Astronomy and Materials Science. Faculty Advisor: Robert Patterson.

Yellow supergiant (YSG) stars traverse the Cepheid instability strip during their evolution. However, not all YSG stars have been found to be variable. Observations of seven program YSG stars were made at the Missouri State University Baker Observatory between August and October 2011 to assess their variability. The observatory’s 0.36 m telescope and Apogee u77 CCD camera were used to acquire images. One or both of two spectral class A or F visual binaries were imaged during each observing session for purposes of quality control. We found that five of the program YSG stars showed no variability at a precision level of 1%. One other YSG star showed probable low-level variability and the remaining YSG star, UU Her, a known variable star, showed clear variability. Our results support the idea that not all YSG stars are variable. Although they have some similarities, YSG stars appear to represent a heterogeneous group of post-main sequence stars. Differences contributing to the presence or absence of significant variability might include their particular stage of evolution, mass, or chemical composition.

#33 - MOLYBDENUM OXIDE ELECTROCHROMICS AND ANODE PROPERTIES. Aron McCart, Physics, Astronomy and Materials Science. Faculty Advisor: Saibal Mitra

In this paper we describe the deposition and characterization of thin films of molybdenum oxide (MoOx). MoOx films were deposited by pulsed laser deposition (PLD) and electrodeposition. MoOx has attracted wide spread interest because they make excellent anodes for lithium ion batteries. MoOx also exhibits electrochromic properties and hence can be used in smart windows. MoOx samples were deposited using PLD at various oxygen levels. A 238nm Krypton laser with energy 300mJ/pulse was used to ablate a MoOx target. The ablated material then traveled by line of sight on to a glass substrate. Visually, the color of the films varied with oxygen content. The color of the films changed from dark to transparent with increasing oxygen content. Once deposited the samples were also characterized by x-ray diffraction. Also, MoOx thin films were deposited using electrodeposition for possible applications in lithium ion batteries. The electrolytic cell contained molybdic acid for the electrolyte, stainless steel for the substrate, and a graphite plate acted as the counter electrode. The characterization and results will be discussed in greater detail.
#34 - METAL-METAL OXIDE NANOCOMPOSITE FOR SOLAR CELL APPLICATIONS. H. Gemar, K. Ghosh, Physics, Astronomy and Materials Science. Faculty Advisor: Kartik Ghosh

Currently, there is a large need for alternative energies and one good option is solar cells. A High efficiency solar cell generally consists of a number of thin layers: active layer consisting of a material having high absorption in the solar spectrum, transparent conducting layer, p- and n-type materials used to fabricate the junction, and electrodes for good ohmic contacts. Here we are focusing on the optimization of the active layer consisting of metal-metal oxide nanocomposite. The presence of metal nanoparticles in metal oxide films improves significantly the solar absorbance of metal oxide films. The absorption depends on the bandgap of the materials, and the bandgap of metal oxide can be tuned by incorporation of metal nanoparticles. Tuning of the bandgap and absorption are the very important parameters to fabricate the solar cell devices. Thin films of M-MO (M = transition metals Co and Ni) nanocomposite have been grown on quartz substrate using pulse laser deposition technique. Structural properties have been characterized using X-ray diffraction and scanning electron microscopy. Electrical properties with and without light and absorption spectra have been measured using I-V characterization and UV-VIS spectroscopy techniques. Detailed results will be discussed in the presentation.

#35 - INVESTIGATING METHODS OF PIEZOELECTRIC PRINTING CONDUCTING CARBON NANOMATERIALS ONTO FLEXIBLE SUBSTRATES. Jacob Swett, Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Lifeng Dong.

In the past few years, carbon nanotubes and graphene have garnered interest in their potential for increasing the efficiency of photovoltaic cells by their incorporation into electrodes of flexible substrates. In order to fabricate devices for continued research, it is desired to have an efficient and cost-effective method for applying the electrode to a substrate. By developing methods of piezoelectric printing various nanomaterial based inks, electrodes and other components of a photovoltaic cell can quickly and carefully be deposited. This presentation will discuss the necessity of utilizing the piezoelectric effect to be able to print the various inks, the procedure for preparing inks for printing, and an analysis of the results of printing trials.


The adsorption of lanthanide ions under hydrothermal conditions modifies the physical and chemical properties of metal oxide nanoparticles, making these suitable for applications in the conversion and storage of energy. The reactivity of Eu³⁺ ions with anatase TiO₂ nanoparticles under high temperatures and pressures in aqueous fluids is under investigation. The hydrothermal treatment of TiO₂ nanoparticles with Eu-bearing aqueous solutions is carried out using our specially built reactor made from Hastelloy C-276 material. X-ray diffraction measurements show that the untreated TiO₂ nanoparticles are of anatase crystalline phase with an average particle size of 12.9(8) nm. We have successfully reacted TiO₂ nanoparticles with Eu³⁺ ions in europium(III) nitrate aqueous solutions heated to 360 °C. Under low pH conditions, the hydrothermally-treated TiO₂ nanoparticles in the presence of Eu³⁺ ions show that they remain anatase whereas at high pH conditions the nanoparticles undergo partial conversion to brookite and rutile phase. We discuss characterization of Eu-reacted TiO₂ nanoparticles using scanning electron microscopy (SEM), x-ray diffraction, and superconducting quantum interface device (SQUID) magnetometry.
#37 - PULSED LASER SYNTHESIZED GOLD AND COBALT NANOPARTICLES FOR BIOMEDICAL APPLICATIONS

Nanomaterials research has become a major attraction in the field of advanced materials research in the area of Physics, Chemistry, and Materials Science. Bio-compatible and chemically stable metal nanoparticles have biomedical applications that includes drug delivery, cell and DNA separation, gene cloning, magnetic resonance imaging (MRI). This research is aimed at the fabrication of nonmagnetic gold and magnetic cobalt nanoparticles using a safe, cost effective, and easy to handle technique that is capable of producing nanoparticles free of any contamination. Gold and cobalt nanoparticles have been synthesized at room temperature using cobalt and gold foil by pulsed laser ablation technique. These nanoparticles were characterized using UV-Visible (UV-Vis) spectroscopy, Field Emission Scanning Electron microscopy (FESEM), and dynamic laser light scattering (DLS). The nanoparticles were stabilized in glucose solutions of various concentrations in deionized water. The presence of UV-Vis absorption peak at 525 nm for gold and at 270 nm for Co validates the nature of gold and cobalt nanoparticles, respectively. The DLS size distributions of nanoparticles are in the range of 110 to 300 nm, which further confirms the presence nanoparticles. This work is partially supported by National Science Foundation (DMR- 0907037) and the National Cancer Institute (1 R15 CA139390-01).

#38 - MAGNETIC ELEMENT DOPED TRANSPARENT CONDUCTING IN$_2$O$_3$ THIN FILMS FOR SPINTRONIC APPLICATIONS.

Tremendous research efforts are underway to exploit the property of electron spin in spintronics. Spintronic devices critically depend on the availability of a specific materials system for spin injection, manipulation and detection. Transition metal (Cr, Fe, or Co) doped wide band gap oxide semiconductors possess these properties. Indium oxide (In$_2$O$_3$) is a wide band gap semiconductor with unique optical and electrical properties. Here, we investigate the effect of Cr, Fe, or Co doping on electrical and optical properties of In$_2$O$_3$ thin films. Thin films have been grown on sapphire and quartz substrates using pulse laser deposition method. Electrical and optical characteristics have been measured using UV-VIS spectroscopy and magneto-transport techniques. Optical transmittance and electrical parameters such as carrier concentration and carrier mobility vary with growth parameters such as growth temperature of the substrate and oxygen pressure of the chamber. These details will be discussed during this presentation.

#39 - MODELING A SHORT PERIOD ECLIPSING BINARY– 2M1938+4603 OBSERVED BY KEPLER.
Laurel Farris, Physics, Astronomy and Materials Science. Faculty Advisor Andrzej Baran

The goal of our project is to solve the binary system 2M1938+4603. This system consists of a subdwarf B (sdB) star and a low-mass M dwarf companion. The data were obtained by the Kepler satellite during Q5,6 and Q7. The light curve of this system shows distinct primary and secondary eclipses along with a reflection effect caused by the hotter sdB star heating up the surface of the cooler companion. The eclipses were used to calculate the orbital period and then phase data for modeling. An O-C (observed minus calculated) diagram was constructed which helps to monitor orbital period changes. The phased data were modeled, but did not accurately derive the observed shape of the light curve. The reflection effect is suspected to be the reason for this. Nevertheless, a Fourier analysis performed on data with orbital trend removed uncovered pulsations characteristic for sdB stars. This system appears to be very challenging for binary modeling, however, when successful, both orbital solution and pulsation analysis can be used to constrain the model of this system helping to better understand evolution theory of binaries and individual stars as well.