Biology * Chemistry * Computer Science * Astronomy * Physics * Mathematics

The College of
Natural Sciences and Mathematics

University of Central Arkansas

Abstracts

The 20th Annual Student Research Poster Symposium

April 18, 2014
2:00 - 4:00 pm

McCastlain Hall Ballroom

REFRESHMENTS WILL BE SERVED

COME MEET SOME OF OUR NATION'S FUTURE SCIENTISTS
AND LEARN ABOUT THEIR RESEARCH PROJECTS!

Introduction from the Dean's Office

This book contains the abstracts for the 20th Annual College of Natural Sciences and Mathematics Student Research Symposium. The symposium highlights graduate and undergraduate student research projects completed under the guidance of faculty in the departments of Biology, Chemistry, Computer Science, Mathematics, and Physics and Astronomy. This event has grown every year. This year's program includes 64 abstracts with 112 student authors, 37 faculty mentors, and 2 external mentors. The opportunity to apply knowledge to real problems is an important component of the education that students receive at UCA. This symposium is an occasion to celebrate the scientific achievements of our students.

Biology

Protective Mechanisms of Estrogen-induced Downregulation of Voltage-gated Ca²⁺ Channels in Coronary Arteries

Edouard Niyonsaba, Mohamed Idrissa Moussa, Robin J. Dalton
Faculty Mentors: Brent J.F. Hill, Nancy J. Rusch

Many vascular dysfunctions demonstrate an upregulation of voltage-gated, L-type Ca2+ channels (VGCCs). Previously, our lab has shown that estrogen (E2) can downregulate VGCCs, and thus, prevent excessive vasoconstriction. The aim of this study is to determine the mechanisms associated with this E2-induced downregulation. The right coronary arteries were obtained from hearts of female pigs and were sectioned into longitudinal strips (Western blots, real-time PCR) or rings (isometric tension) and incubated for 24 hrs in 1nM E2 or EtOH (E2 solvent). Total mRNA was isolated and the relative mRNA abundance was determined using real-time PCR. There was similar abundance of the alpha1C transcript between EtOH and E2 treated arteries. This suggests that the E2-induced downregulation of VGCCs are posttranscriptionally regulated. To determine if the downregulation occurred via estrogen receptors (ER), the arterial strips were individually incubated for 24 hrs in 1nM E2, EtOH, an estrogen receptor (ER) alpha/beta antagonist (ICI 182,780), and a G-protein-coupled ER antagonist (G-15). G-15 experiments are still an ongoing. The arterial strips were homogenized for Western blot analysis using an antibody reactive to the VGCC alpha1C subunit. Our results indicate that E2 mediates the VGCC downregulation via activation of ERalpha/beta. The role of the endothelium was evaluated by mechanically removing the endothelium of the artery with a toothpick before the 24 hr incubation period. The Western blots indicated that the presence of the endothelium did not affect the expression of the VGCC alpha1C subunit. Isometric contractions were also measured to the VGCC agonist, FPL64176, in endothelial intact and removed rings. Although E2 decreased the FPL64176 contraction by 50%, the presence of the endothelium had no effect. Therefore, the E2-induced VGCC downregulation is endothelium-independent. Overall, these results provide mechanisms associated with the protective effects of E2 against vascular dysfunctions in premenopausal women. Support: Grant #P20 GM103429-11.

Phylogenetic Relationships of *Erigeron geiseri* (Asteraceae) using ITS/ETS DNA Sequencing

Will Caraway
Faculty Mentor: Dr. Richard D. Noyes, Department of Biology

Molecular systematics uses DNA sequence to investigate evolutionary relationships among species. *Erigeron geiseri* (a small annual in the sunflower family, Asteraceae) is a poorly understood

species that occurs in central Texas originally described in 1947 by Lloyd Shinners. Several hypotheses have been published in the past regarding possible affinities to other species in *Erigeron*. Our goal was to use the sequences of the internal transcribing spacer (ITS) and external transcribing spacer (ETS), regions of about 600 base pairs each found in nrDNA, to build a phylogeny. These gene regions are commonly used to study species relationships in plants. To accomplish our goal we sequenced DNA obtained from five herbarium specimens on loan from universities in Texas with representative geographic sampling. Using phylogenetic analysis, we were able to place *E. geiseri* in a phylogenetic tree with other *Erigeron* species and determine that *E. geiseri* is most closely related to *E. strigosus* and falls within the *Phalacroloma* section of *Erigeron*.

Identification of Novel Regulators of a Calcium Calmodulin Dependent Protein Kinase (DMI3) Controlling Plant-microbe Symbioses

Student Author(s): Shane Radford, Jonathan Pennington, Aakash Rana
Faculty Mentor(s): Arijit Mukherjee

Acquisition of nitrogen from the soil is a major issue for sustainable agriculture leading to an increasing dependence on fertilizers. In order to minimize the economical, ecological and health hazards associated with such treatments, we need to take advantage of beneficial plant-microbe interactions like root nodule symbiosis. Legumes have the ability to form a very efficient nitrogen-fixing symbiosis with soil bacteria, rhizobia. Unfortunately, very few efficient nitrogen-fixing symbioses exist outside of the legume family. Therefore, in order to engineer efficient nitrogen fixation in non-legumes, we need to better understand the mechanisms underlying the establishment of the rhizobium-legume symbiosis. Genetic studies in model legumes identified several genes that are required for the establishment of this symbiosis. Among them, a nuclear calcium and calmodulin-dependent kinase (CCaMK), called DMI3, acts as decoder of calcium spiking. Mutants in *DMI3* are affected in most responses to rhizobia and are unable to form nodules or to induce nodulin gene expression (e.g. *ENOD11*) in presence of rhizobia. *DMI3* and other genes are also required for the establishment of mycorrhizal symbiosis, which led to the concept of a shared "common symbiotic pathway" between these two major endosymbioses. Interestingly, *DMI3* is highly conserved in non-legumes and is required for mycorrhizal symbiosis in rice. This is exciting since it means that some elements for nitrogen fixation are already present in cereals. However, our knowledge of the pathway is still fragmentary. Our project focuses on identifying new regulators of *DMI3*. We intend to identify genetic loci regulating *DMI3* using a suppressor screen. This classical but powerful genetic tool has not yet been exploited to dissect the common symbiotic pathway. Thus, our approach will identify pathway components that have been missed in conventional screens and generate new knowledge about the molecular basis of symbiotic relationships that could be applied to other crops.

Hypothalamo-Pituitary Interrenal (HPI) Axis Modulation in a Subarctic Wood Frog (*Lithobates sylvaticus*) Population and Congeneric Variation of Temperate Lithobatids

Phillip Seiwert
Faculty members: Dr. Ben Cash

How an organism reacts to environmental changes is crucial for survival and homeostasis. Measuring changes in hormone production can be used to assess the interaction between an organism and its environment. Corticosterone is the major hormone produced when an organism perceives a stressor. By quantifying this hormone, researchers can determine the sensitivity of the stress response and determine if this sensitivity is consistent among groups of organisms. While little is known about the stress physiology of amphibians, they are a useful model group to study as they are especially susceptible to changes in their environment, and may therefore be more susceptible to stress. In this study, plasma corticosterone concentrations of subarctic wood frogs (*Lithobates sylvaticus*) were measured and compared with a temperate wood frog population, as well as three other congeneric species. Preliminary data support that the individuals in the northern population are less sensitive to handling stress than that of temperate species. Differences in stress sensitivity also were found to exist between males and females, and during and after breeding seasons.

Shredder Excretion and its Effects on Leaf Litter Breakdown

Steven Polaskey
Faculty Mentor: Dr. Sally Entrekin

Leaf litter is the primary energy and nutrient source for biota in forested streams. The rate at which leaf litter decomposes determines the amount of energy and nutrients available to higher trophic levels. Macroinvertebrate leaf shredders directly increase leaf decomposition via consumption, but could also indirectly stimulate leaf decomposition via excretion. Shredders consume leaf litter and excrete partially digested nutrients that can stimulate carbon mineralization when microbes on leaves are nutrient limited. We predicted shredder excretion would stimulate decomposition by increasing nutrient availability to microbial decomposers. A 35 day laboratory experiment compared indirect effects of *Tipula* on leaves with low and high carbon:phosphorus (C:P). Microbial respiration was significantly higher in both the high C:P treatment and when *Tipula* were present ($p=0.0003$). Mass loss was significantly different between the treatments ($p<0.0001$). High C:P leaves lost more mass than low C:P leaves ($p=0.02$); but there was no difference with *Tipula* present or absent ($p=0.19$). Increased nutrients from *Tipula* presence affected only microbial respiration. Initial leaf C:P affected both microbial respiration and leaf breakdown, indicating that leaf C:P has a stronger influence on decomposition than the *Tipula* nutrient additions. Difference in microbial communities might explain these results. *Tipula* excretion could labile for only microbial communities on high leaf C:P, which suggests differences in nutrient demand. The Leaf C:P was a major factor in determining leaf decomposition, but indirect effects of macroinvertebrate excretion can stimulate the microbial community, increasing the energy available to higher trophic levels.

Sodium Concentration Effects on Microbial Respiration and *Tipula Abdominalis* Growth

Meredith Tyree and Steven Polaskey
Faculty Mentor(s): Sally Entrekin and Natalie Clay

Sodium ion concentrations are rising in streams across the United States from road deicers, water softeners, fertilizers, and weathering of rock exposed by mining and drilling. Pulsed high concentration sodium additions reduce biological diversity in streams by interfering with osmoregulation. Conversely, addition of sodium in terrestrial environments relieves sodium limitation in detritivores and increases taxa diversity and decomposition rate of detritus. The effects of low concentration chronic sodium additions on aquatic detritivores have not been well studied. Sodium concentrations are positively related to gas activity in some streams within the Arkansas Fayetteville shale natural gas play. Sodium concentrations ranged from ~1 to 7 mg/L across a well density gradient, orders of magnitude lower than in other studies. We predicted that a relatively small increase in sodium concentration would alleviate sodium ion limitation and increase aquatic detritivore consumption and production under controlled experimental conditions. Conditioned sweet gum leaves were placed in 15 containers of low (3mg/L) and 15 containers of high (7mg/L) stream water sodium concentrations. Ten *Tipula* (important macroinvertebrate detritivores) were placed in each sodium treatment for 28 days. Five containers in each treatment had leaves and not *Tipula.* Microbial heterotrophic activity in the chambers without *Tipula* was measured as respiration on day 28 and did not differ between treatments (p=0.45). *Tipula* leaf consumption did not differ at days 6-8 (p=0.59), but was lower on days 13-15 in the high sodium treatment (high 30.84mg/day, low 49.82mg/day, p=0.001). *Tipula* growth did not differ between treatments (p=0.84). Lower consumption later in the experiment could indicate long-term effects of relatively low sodium concentrations on osmoregulation of aquatic biota. A longer duration study is needed to confirm adverse effects on *Tipula* consumption and identify any alterations to growth.

Regulation of the Formation of Hormone-induced Nodule-like Structures in Cereals by Genes from the Common Symbiotic Pathway

*Student Author(s): **Ryan Hiltenbrand, Hannah Posey**, and **David Zimulinda***
Faculty Mentor(s): Arijit Mukherjee

Availability of nitrogen is a major constraint for crop productivity and this has led to an excessive dependence on fertilizers. Unfortunately, there are many negative consequences for fertilizer usage. One alternative is to take advantage of plant-microbe symbioses. The most efficient plant-microbe symbioses are with arbuscular mycorrhizal (AM) fungi, and nitrogen-fixing bacteria, rhizobia. More than 85% of plants can form a symbiosis with AM fungi that benefits the host plant in improved nutrient uptake from the soil. The more recent symbiosis is efficient in atmospheric nitrogen fixation and occurs between legumes and rhizobia. In this process, the rhizobia fix atmospheric nitrogen for its host plant inside specialized root structures, nodules. Genetic studies in model legumes identified several genes that are required for the establishment of these associations. Some of these genes are required for both these symbioses. This has led to the

concept of the common symbiotic pathway (CSP). Some of these CSP genes are also present in cereals and are required for AM symbiosis. This means that some components required for nitrogen fixation are already present in cereals. Other studies revealed that plant hormones such as auxins and ethylene play key roles in establishment of these symbioses. For instance, auxins have been shown to induce the formation of nodule-like structures (NLS) in roots of *Medicago truncatula* in the absence of bacteria. Transcriptomic studies in *M. truncatula* revealed genes that lead to the formation of these NLS. Interestingly, in cereals addition of auxin stimulates the formation of similar root structures. Unfortunately, our knowledge of NLS formation in cereals is still fragmentary. For example, the host genes controlling the formation of these NLS in cereal roots are still unknown. In this study we investigated the formation of NLS under different conditions and their regulation by genes from the common symbiotic pathway.

Investigating the Formation of Hormone-induced Nodule-like Structures in Cereals

Student Author(s): Ryan Hiltenbrand**, **Hannah Posey**, and **Kasi Weathers
Faculty Mentor(s): Arijit Mukherjee

Availability of nutrients is a major constraint for crop productivity and sustainable agriculture. Over the last decades, there has been an excessive dependence on fertilizers with dire economic and ecological consequences. Taking better advantage of beneficial plant-microbe symbioses is a promising alternative to improve crop yields while maintaining agricultural sustainability. The two most efficient plant-microbe symbioses are the ones with nitrogen-fixing bacteria, rhizobia, and with arbuscular mycorrhizal fungi. In both these symbioses the plant benefits by improved nutrient uptake. While associations with nitrogen-fixing bacteria are limited to legumes, more than 85% of land plants (including cereals) can form symbioses with mycorrhizal fungi. Over the last decades genetics in model legumes identified several key plant genes that are required for the establishment of these associations. Some of these genes are required for both these symbioses. This has led to the concept of the common symbiotic pathway (CSP). Some of the CSP genes are also present in cereals and are required for AM symbiosis. This means that some components required for nitrogen fixation are already present in cereals. Studies have shown that plant hormones such as auxins and ethylene also play significant roles in establishment of these associations. For instance, auxins have been shown to induce the formation of nodule-like structures (NLS) in roots of *Medicago truncatula* in the absence of bacteria. Interestingly, in many cereals such as wheat and corn, addition of such hormones induces the formation of NLS and this stimulates nitrogen fixation. Unfortunately, our knowledge of NLS formation in cereals is still fragmentary. In this study we are investigating the formation of NLS under different conditions and are comparing NLS between rice and Medicago roots. In the long term, we plan to investigate the genetic pathways controlling NLS formation in cereals.

Of Mice and Men (Of Pups and Children)

Skylar Daly and Jacinda Webb
Faculty Mentor: Dr. Barbara Clancy

Previous work in our lab established a web-based tool to "translate time" using statistical methods that convert dates of brain developmental milestones in experimental species to the corresponding dates in humans. Using this unique method, we can now more accurately compare maturation between test species and children. We questioned whether studies previously completed in experimental species pertaining to anesthesia intervals, drug administration, and vaccination ages had used appropriate developmental times. Surprisingly, this question has never been sufficiently addressed, as laboratories typically use untested proportions ("dog" years), or unconfirmed rules of thumb (*i.e.* rat pup brain development at 1 week = human brain at birth). Our pilot research suggests that many vaccines were tested at inappropriate comparative ages. Indeed, most experimental rodent pup brains were more developed at testing times than the human ages that were considered to correspond. Further testing is required to ensure that treatments are not administered to children during what we now understand is a period of relative immature brain development. Current research is underway that will incorporate the more accurate brain developmental comparative ages and include additional organs, such as intestines, livers, and hearts.

Literature Review of Parkinson: Evidence of a Mitochondrial-linked Etiology

Stephanie Dayer
Faculty Mentor(s): Dr. Kari Naylor

Parkinson's disease (PD) is a neurodegenerative disorder characterized by bradykinesia, rigidity, and tremor. These motor symptoms manifest due to the apoptosis of dopaminergic neurons in the zona compacta of the substantia nigra of PD patients (Schapira). The cause of the dopaminergic neuron death remains unknown, but environmental and genetic factors have been considered as essential aspects in Parkinson's etiology. Other characterizations of PD are oxidative stress and the development of lewy bodies, which is an aggregate of predominantly alpha-synuclein and Omi/HtrA2.

There are two forms of Parkinson's disease: Sporadic and Familial. Early Parkinson's research focuses on the more common idiopathic or sporadic Parkinsonism looking into environmental factors that attribute to its development. A noted reduction in mitochondrial NADH dehydrogenase complex (Complex 1) activity has been investigated as a possible contributor to the dopaminergic death in PD. Investigation into various neurotoxins, pesticides, and other environmental factors has shown reductions in complex 1 activity indicating an increased risk of developing parkinsonism upon exposure. Investigating familial forms of Parkinson's disease has identified genetic mutations in Pink1 and parkin linked to the development of Parkinsonism. Mutations in, the components of Lewy bodies, alpha-synuclein and Omi/HtrA2, indicate a possibly a connecting mitochondrial mechanism between idiopathic and familial Parkinsonism.

The Impact of Natural Gas Development on Fish Communities of the Fayetteville Shale, Arkansas

Brittany V. Furtado and Jessie J. Green
Faculty Mentor(s): Ginny Adams and Reid Adams

The Fayetteville Shale has experienced exponential growth in gas well development over the last decade, yet the long-term effects of unconventional gas well development on aquatic communities remain relatively unknown. In spring 2012 and 2013, we sampled 12 sites throughout the eastern Fayetteville Shale in north central Arkansas. Fishes were sampled quantitatively using backpack electrofishing and three-pass depletion at multiple riffle-pool units per site. We examined percent sensitive taxa, percent darters, percent Green Sunfish *Lepomis cyanellus*, and species richness in relation to increasing gas well development. Pairwise correlations from both spring 2012 and 2013 show persisting relationships for all variables, except species richness. Proportional abundance of sensitive taxa ranged from 19.5 to 63.0% (2012) and 16.6 to 78.2% (2013) and was negatively correlated with gas well density in both years (2012: r= -0.81; 2013: r=-0.75). Proportional abundance of darters ranged from 6.1 to 63.0% (2012) and from 0.0 to 78.2% (2013) and was negatively correlated with gas well density (2012: r= -0.84; 2013: r=-0.70). Proportional abundance of *L. cyanellus* ranged from 1.31 to 23.6% (2012) and 0.0 to 47.4% (2013) and was positively correlated with gas well density (2012: r= 0.61; 2013: r=0.77). We used partial correlations to examine the strength of the relations to gas well density when % pasture, the only significant land use variable, was held constant. With the exception of species richness all other variables showed the strongest relationship with gas well density in each year. Results from both years indicate persisting disturbance at the study sites strongly linked to gas well development.

Differences in Photosynthesis and Leaf Temperature in Pima and Upland Cotton

Student Author: Dylan Glover
Faculty Mentor: John Choinski

The purpose of this research is to determine which of the two cotton species Pima (*Gossypium barbadense L.*) and Upland (*Gossypium hirsutum L.*) would thrive better in warmer climates and which one has a higher photosynthesis rate at higher temperatures. The research questions were: *1) What are the patterns of leaf temperature in expanding leaves of Pima and Upland cotton grown under similar greenhouse conditions? 2) How do photosynthesis/leaf temperature responses differ in Pima and Upland cotton?* The two species were started from seeds in the growth chambers and then transferred to the green house and measured at ~50 days old. Leaves from node 2 (young) and node 5 (more mature) were used for the taking temperatures and measurement of photosynthesis. To measure abaxial leaf temperature, a fine wire thermocouple linked to an Omega data logger was used. Photosynthesis of leaves at different temperatures was measured using a portable PAM chlorophyll fluorometer. We found in both species, young leaves were warmer throughout the day than the more mature node 5 leaves, although differences between

the species were not as clear. The two cotton species also had a different pattern of photosynthetic thermo-tolerance. The Pima plant node 2 leaves had a higher thermo-tolerance than the node 5. The node 2 leaf had a peak photosynthesis measure at 35^0C and really did not decline a whole lot until it got to 50^0C. The Upland plant showed that the node 2 leaf had a higher thermo-tolerance than node 5. Node 5 leaves had peak photosynthesis at 35^0C and really did not decline a whole lot until it got to 50^0C. We conclude that Pima and Upland cotton differ in diurnal leaf temperature and thermal tolerance; these differences may help explain why Pima cotton is grown in hotter ands drier climates than Upland.

Autophagy and Telomerase Inhibitors in Brain Tumors

Lauren Hyde
Faculty Mentor: Dr. C. Marian

Cancer has high mortality rates around the world and one of the most recent treatment strategies is targeting the telomeres. Telomeres are complex nucleoprotein structures that cap the end of linear chromosomes. In normal somatic cells, the telomeres shorten with each division, due to the end-replication problem. Telomerase is the enzyme responsible for telomere maintenance in some normal cells and majority of malignant tumors. One of these malignant tumors is glioblastoma, a lethal form of brain cancer. The malignant transformation and metastasis are believed to be driven by small population of cells known as cancer stem cells (CSCs). It was previously shown that brain CSCs treated with a telomerase inhibitor display significant short and long-term effects. While the long-term effects are due to critical telomere shortening in absence of telomerase, the short-term effects were surprising. We hypothesize that this effect could be explained by autophagy. Autophagy is a form of cell death that occurs when the cell undergoes degradation of organelles before nuclear destruction. APG/ATG proteins are essential for autophagy and were seen to be up-regulated in myeloma cells treated with telomerase inhibitors. This effect suggests that the same mechanism could be taking place in glioblastoma. We propose future experiments with brain CSCs to observe the expression levels of critical autophagy genes. This information would provide more evidence about the mechanism of cell death in glioblastoma cells treated with telomerase inhibitors.

Determining the Effect of Actin Depolymerization on *Dictyostelium discoideum cluA*- Cells

Jordyn Cleavenger
Faculty Mentor: Kari Naylor

In wild type cells mitochondria are scattered throughout the cell in no particular pattern. In *Dictyostelium discoideum* cells, that lack the protein CluA, the majority of mitochondria are clumped in one area, and are connected together by thin membranous tubules. It has been suggested that normal mitochondrial distribution is necessary for proper ATP and metabolite targeting in cells. The goal of my project is to investigate how to recover the wild type phenotype

in a cell that lacks the CluA protein.

   Analysis of the CluA protein suggests that it may be a linker protein, serving as an intermediary between the mitochondria and a motor protein traveling along a cytoskeletal track. Recent work in our lab and others has shown that the cytoskeleton is needed to maintain a fully wild type distribution of mitochondria. The actin cytoskeleton gives a cell its shape and can play a role in moving organelles to move from place to place. Since actin can regulate organelle motility, I hypothesize that when CluA is missing mitochondria will clump together, and by inhibiting actin the mitochondria will be allowed to disperse into its normal distribution.

    This project is meant to study the effects of the cytoskeleton on *CLUA* knockout cells. I believe that the loss of interaction with actin in *cluA-* cells is the reason the mitochondria clump together. This assumes mitochondria move along actin, so if actin is inhibited then mitochondria will be free to move about on their own, distributing themselves across the cell.

Whole Chloroplast Genome Sequencing for Asteraceae

Brittanie Kling
Faculty Mentor: Dr. Richard D. Noyes

Chloroplasts contain their own set of circular DNA, the structure of which is highly conserved among plant species. It is relatively small in size, with a typical genome containing about 150 kb of DNA, which makes it very useful for studying chloroplast genome evolution and phylogenetic relationships. We studied chloroplast genomes of 10 plant species in the Asteraceae family that occur within the diverse tribe Astereae. These include: *Felicia*, *Baccharis* (Southern Hemisphere), plus *Doellingenia*, *Boltonia*, *Symphyotrichum* (*Aster*), *Solidago*, *Erigeron strigosus*, *Erigeron neomexicanus, Bradburia,* and *Euthamia* (Northern Hemisphere). Enriched organellar DNA was isolated from plant extracts using a recently published modified high salt method. This method involves multiple rounds of centrifugation and serves to eliminate most the nuclear genomic DNA. Electrophoresis results showed that the high salt method is an effective way to enrich for organellar DNA that is suitable for sequencing the chloroplast genomes of each species. All samples have been successfully sequenced and are awaiting bioinformatics analysis.

Estrogen Depletion Effects Contractility of Mesentery Arteries via Voltage-Gated Calcium Channels

Lachan Layton
Faculty Mentor(s): Brent Hill

There is an extremely high incidence rate of cardiovascular disease among postmenopausal women and this has been linked to the lack of estrogen in their blood stream. L-type voltage-gated calcium channels are the primary channels responsible for inducing the constriction of arteries. In women, estrogen assists in maintaining normal vascular tone by limiting the accumulation of calcium in the smooth muscle cells, which comprise arteries. Our objective is to determine if

estrogen depletion will affect calcium channel mediated contraction in the resistance arteries, (i.e. mesentery arteries) of a mouse. Female mice are subjected to either an ovariectomy (OVX) or simulated ovariectomy (SHAM) at eight weeks of age. Later, at sixteen weeks of age, the mesentery arteries are dissected out, mounted in a perfusion chamber and subjected to increasing concentrations of FPL64176. FPL is a selective agonist for L-type calcium channels and therefore, causes constriction of the vessel. Our preliminary data shows that the uterine weight of the SHAM sample was significantly greater than the uterine weight of the OVX sample. When total body weight was compared, the OVX mouse sample was significantly higher than the SHAM sample. However, there is not a significant difference in the contractile ability of a mesentery artery from an OVX mouse versus an artery from a SHAM mouse.

Molecular Cloning to Improve Mitochondrial Fission and Fusion Assays in *Dicytostelium discoideum.*

Olivia Vogel, Addie Milam, Kayln Holloway
Faculty Mentor(s): Dr. Kari Naylor

The purpose of our research is to create several constructs to be used to study mitochondrial fission and fusion. Our first construct is a mitochondrial targeted red fluorescent protein (RFP). This will enable the mitochondria to be visible *in vivo* with the use of a fluorescent microscope. These fluorescently labeled mitochondria may then be used to study mitochondrial dynamics. The cloning process we used can be divided into four main steps: polymerase chain reaction, digestion, ligation, and transformation. In our research, we have currently performed all steps and created our construct. Our construct contains a 35 amino acid mitochondrial targeting sequence linked to the red fluorescent protein, mCherry. This is inserted into the *Dictyostelium discoideum* expression vector pDXA-3H.   Now we must screen our colonies for the correctly assembled construct. If our initial cloning experiment is determined to be unsuccessful, then sources of possible error will be considered, the procedure will be modified accordingly, and additional attempts will be performed.

Our second construct is a tagged version of the mitochondrial protein CluA. We will tag CluA with the epitope tag FLAG and transform it into our *D. discoideum* cells. Using this epitope tag we can perform pull-down assays to identify what proteins interact with CluA. This will give us more insight into the function of CluA.

The cloning process for this construct is similar to our mitochondrial targeted RFP but since this gene contains introns we must first make cDNA before we begin the cloning process itself. We are currently in the process of isolating RNA and generating our cDNA.

Regulation of *FAD* Genes During Cotton Leaf Expansion
Student Author: Harold Owiti
Faculty Mentor(s): John Choinski, Arijit Mukherjee

Cotton is one of the main commercial fiber crops grown in warm regions around the world including Arkansas. Cotton production faces challenges, however, in that climatic changes

including increased global warming will eventually lead to insufficient irrigation water and lower yields especially in developing countries. Previous studies done with cotton show that young leaves are particularly well adapted to survive heat stress with higher photosynthetic thermal tolerance possibly because they have higher proportions of saturated fatty acids in their chloroplast membrane lipids when compared to more mature leaves. In this project, we hypothesized that the expression levels of four different FAD (fatty acid desaturase) 2 gene isoforms will increase as the leaves expand. FAD genes code for enzymes that function by adding double bonds to pre-existing fatty acids, thus decreasing the level of lipid saturation. We will show data using standard molecular techniques, including PCR, that compare FAD 2 expression levels in greenhouse-grown, young (node 2) with more mature (node 5) leaves. Our research is important because an understanding of the genetics of how cotton plants survive elevated temperatures will help to develop new crop varieties in preparation for dealing with the expected climatic changes.

Variation in Streamwater Conductivity in the Cadron Watershed

Carolyn Pollard
Faculty Mentor: Sally Entrekin

Headwater streams make up between 50-70% of total river networks within the United States. Headwater streams are integral in maintaining the overall health of aquatic ecosystems because they sequester pollutants, transport nutrients from the surrounding landscape downstream, and provide specialized habitat for aquatic biota. Various aquatic macroinvertebrates are adapted to water quality conditions; therefore, their community structure reflects water quality. Specific conductivity, or water's ionic property, is a good indicator of water quality as it tends to increase with land use changes. For example, increased agriculture and urbanization often result in increased conductivity by increasing oils, metals, and fertilizers draining into surface waters. Elevated conductivity can disrupt macroinvertebrate water balances and ion exchange processes. The Cadron creek watershed, located within the Arkansas River Valley ecoregion, has among the lowest conductivity (30-50uS/cm) within the United Sates. However, landuse changes such as agriculture, urbanization, and natural gas activity could increase conductivity and negatively impact the macroinvertebrates that are adapted to low conductivity. For this study, specific conductivity was measured from 162 stream sites within the Cadron creek watershed. We predicted that conductivity would be greater in perennial streams when compared to intermittent streams from differences in discharge. Conductivity did not differ between perennial and intermittent streams (mean=63.20,SE=2.53; p=0.70). However, intermittent streams represented 70% of total streams sampled. Therefore, high and low conductivities in the intermittent streams were identified as those in the lower 25th and upper 75th percentile. Macroinvertebrate samples were taken from three streams with high and three streams with low conductivities in three riffles per site. Abundance of macroinvertebrates and percentage of sensitive taxa were compared. Macroinvertebrate community metrics in high and low conductivity streams will be presented.

The Role of Type II Cadherins in Development and Disease

Ethan Clement
Faculty mentor: Dr. Marian

Cadherins are Ca^{2+} dependent cell to cell adhesion proteins that can be classified into 6 families and 19 subfamilies. The function of the Type-I (classical) family of cadherins in animal embryogenesis and disease has been widely studied with well over 14,000 publications available. However, the Type-II (atypical) cadherins are not well characterized. Here, we are going to focus on the role of Cadherin 18 (CDH18) which is an atypical cadherin first identified in the human adult nervous system. Many of CDH18's highly conserved atypical cousins have been implicated in numerous developmental pathways early in embryogenesis especially in the brain and the genitourinary tract, while also being shown to be ectopically expressed during events such as epithelial to mesenchymal transition, tumorigenesis, cyst formation in renal tube cultures and as a marker for pulmonary fibrosis in mice. Mutagenic studies performed on atypical cadherins show that knockout or mutation in the cadherin genes can cause developmental problems especially in neural crest development and nephrogenesis. It has been suggested that CDH18 mutations might play a role in the development of colorectal, breast and renal carcinoma. Preliminary data indicate that in the genitourinary tract CDH18 is expressed early during development. Moreover, overexpression of CDH18 leads to the down-regulation of several genes involved in the process of epithelial to mesenchymal transition. Finally, we discuss future research directions to elucidate the role of CDH18 in development and disease.

Histology of Ecology: How do caterpillars of *Theroa zethus* (Notodontidae) Deactivate Host Defenses?

Madalyn Van Valkenburg
Faculty Mentor: Dr. David Dussourd

Caterpillars in the family Notodontidae typically feed on hardwood trees and sometimes cause extensive deforestation. Some species perform an intriguing behavior known as girdling. They chew a circular groove around petioles or stems, the function of which is currently unknown. An unusual notodontid, *Theroa zethus*, feeds not on hardwoods, but instead attacks herbaceous euphorbs that release latex exudates. *Theroa* employs a technique similar to girdling; however, they do not chew the girdle, but instead compress the stem, petiole, or midrib in a ring with their mandibles. Surprisingly, the plant withers at the girdle. Caterpillars apply to the girdle both saliva from the labial salivary glands and acid from the ventral eversible gland (VEG). The VEG ordinarily serves to spray acid at predators. Using histological techniques, we documented that VEG secretion, not saliva, causes distortion of plant cells in the girdle. Histological sections revealed the unexpected result of intact cell walls despite compression by mandibles and application of caterpillar secretions. The epidermal and cortex cells, which were ordinarily turgid and round, were distorted and compressed, like a jigsaw puzzle. The acid-growth theory proposes that plants

decrease extracellular pH to weaken cell walls during growth. *Theroa* acid may similarly weaken cell walls causing cell distortion within the girdle.

Evaluation of Genome Size Variation in *Erigeron* (Asteraceae) Via Flow Cytometry

Jennifer D. Wagner
Faculty Mentor(s): Dr. Richard D. Noyes, Department of Biology

Genome size estimates along with chromosome numbers establish a starting point for studies of genome evolution, structure, and sequence. *Erigeron* (Asteraceae) is a large genus of annual and perennial herbs that occupies diverse ecological niches. A few species of *Erigeron* have been studied in depth in the context reproductive and adaptive evolution and have been tapped for genome sequencing. However, among the 400 species in the genus, only 2 genome size estimates have been reported (0.5%) in the literature. In this study we investigate genome size for a ploidal series in *Erigeron strigosus* plus 12 other species representing a diversity of sections within the genus. Leaf nuclei were isolated using a standard buffer and analyzed using a Beckman Coulter Cell Lab Quanta flow cytometer. *Pisum sativum* ("Maple Minerva") leaf nuclei served as a size standard. We report the first nuclear genome size estimates for these species, report variation within the genus, and compare genome size estimates for *Erigeron* with those of other Asteraceae.

Corticosterone Secretion in *Graptemys ouachitensis* Associated with Capture and Handling

Luke Pearson
Faculty Mentor(s): Dr. Ben Cash

With drastic changes in natural habitat and ecological communities due to climate change and anthropogenic disturbances, assessing how animals cope with their environment is an important biological question. By assessing an animal's physiological stress response, the sensitivity of the hypothalamo-pituitary-adrenal (HPA) axis can be quantifiably measured using concentrations of stress hormones, specifically corticosterone. In this experiment, Ouachita map turtles (*Graptemys ouachitensis*) were sampled using three-ringed hoop nets, and an initial blood sample (time 0) was acquired within 10 minutes. A final blood sample (time 30) was acquired 30 minutes after initial net disturbance. There was a significant increase in corticosterone from the initial sample (time 0: mean = 0.47 ng/ml ± 0.077 SE) to the stress-induced final sample (time 30: mean = 2.07 ng/ml ± 0.289 SE). There was not a significant difference between male and female stress response, nor a significant effect of relative energetic condition on initial baseline corticosterone concentrations. These results are an important first step towards evaluating the corticosterone secretion profile and sensitivity of the HPA axis of *Graptemys ouachitensis*.

Do Diets of American Eel (*Anguilla rostrata*) Vary Over Different Size Ranges in Arkansas Populations?

Thomas Bridges and Casey Cox
Faculty Mentor: Reid Adams

Little is known about the diet of the American Eel (*Anguilla rostrata)* in Arkansas, although multiple diet studies have been conducted in the Northeastern contiguous United States. These studies have shown eels experience an ontogenetic niche shift in which prey items change to meet energy and nutrient needs which are constantly growing with age and maturation. To determine if an ontogenetic niche shift is present in the Arkansas population of American Eels I obtained 157 American Eels from the Ouachita River drainage during spring and summer months. Mean length of eels was 382 mm and ranged from (236 - 840 mm). I dissected them and analyzed stomach contents. After analyzing the 105 eels that had contents I described the contents to the lowest taxonomic level. I found Arkansas populations of American Eels living in the Ouachita River drainage do not experience an ontogenetic niche shift. This is because crayfish made up 63% of the small eel's diets (0-300mm,n=24), 59% of the middle size eel's diets (301-500mm,n=68), and 69% of the large eel's diets (501-840mm,n=13). Detritus made up the next most frequent stomach content making up 4% of smaller eels diets, 15% of middle size eel's, and 38% of large eel's. Only two stomachs were found to contain fishes and both of which were in the middle size class eel's stomachs. The ontogenetic niche shift is not present because all size classes of eels contained between 59-69 percent crayfish and between 4-38 percent detritus.

Chemistry

Measurement of aerosol optical properties using pulsed laser cavity ring-down spectroscopy (CRDS).

Logan Bevill, Julio Castillo, and Jay Pittman
Faculty mentor: Kristin Dooley

Accurate measurements of optical extinction coefficients and scattering parameters for atmospheric aerosols are needed in order to quantify the effects aerosols have on climate change. Although this field was once dominated by Fluorescence FAGE and long-path absorption spectroscopy DOAS, cavity ring-down spectroscopy (CRDS) has emerged as a cost-effective, accurate alternative technique that has numerous advantages. CRDS is an optical absorption technique based on Beer's Law that allows for the characterization of extremely low concentration target samples by using two highly reflective mirrors to create an optical cavity with a pathlength thousands of times longer than its meter long laboratory footprint. System ring-down information will be monitored and collected using LabView, a program capable of quantifying sensory data and associated ring-down measurements. Well-characterized laboratory generated aerosols of various sizes and compositions will be used to characterize the instrument. We report the current progress of this project.

The Effect of Retinoid Agonists on Cellular Adhesion in K562 Cells Treated with Troglitazone

Connor Nowotny
Faculty Mentor(s): Melissa Kelley

Retinoids are essential for many critical life processes such as cellular adhesion and proliferation. Recently, troglitazone, a PPAR gamma agonist, has been demonstrated to have anti-inflammatory effects. Separately, retinoids and troglitazone are implicated in immune related processes; however, their combinatory role in cellular adhesion has not been well established. In this study, the effect of 9-*cis*-retinoic acid (9-*cis*-RA) agonists and troglitazone on K562 cellular adhesion was investigated. Troglitazone exposure decreased K562 cellular adhesion to RGD containing extracellular matrix proteins fibronectin, FN-120, and vitronectin in a concentration and time-dependent manner. In the presence of troglitazone, 9-*cis*-retinoic acid agonists restored cellular adhesion to FN-120. Our data suggest that in the presence of troglitazone, cells treated with retinoid agonists modulate cellular adhesion to RGD containing extracellular matrix proteins.   Our study is the first to report that the combination of troglitazone and 9-*cis*-retinoic acid agonists restores cellular adhesion in K562 cells.

Isotope Labeling TCA Cycle Intermediates for Metabolomics Study of *C. elegans* with Axenic Media

J. Alex Watts
Faculty Mentor(s):Dr. Bryce Marquis

C. elegans is often used as a model organism for humans because of their microscopic size, transparent bodies, and low cost of maintenance. The worms can be used to model human metabolism as a basis for studies such as drug interactions, longevity, and disease dealing with metabolomics because they display aging and have a relatively short lifespan. The metabolism intermediaries, metabolites, are excreted and can also be extracted internally. The metabolites examined feature carboxylic acid and aldehyde functional groups (e.g. TCA cycle intermediates), which are examined using optimized LC-MS methods. Extracting metabolites at different stages in their lifespan can provide insight into how metabolites fluctuate with age. Using axenic media allows quantitative analysis of metabolite concentrations by comparing standard and isotope labeled nematodes. Acetate is a viable energy source to base the media from because of its low cost compared to common glucose media.

Enriching the K-12 science experience

Hoda H. Agrama, Julio Castillo, Jayln Henderson, Sergio Ivan Perez Bakovic, Johnathon G. Schmidt
Faculty Mentor(s): Karen L. Steelman, Kristin S. Dooley, Faith M. Yarberry

Our chapter has an avid interest in enriching the K-12 science experience. While we have always enjoyed performing chemical demonstrations at local schools, networking opportunities via the UCA STEM Residential College, National ACS Organization, and the Central Arkansas Local Section have allowed us to expand our participation. Chapter activities include Kids' Club, Science Nights, EcoFest, KidsFest, and Bear Fairs. This past year, we have expanded our involvement in a Study Abroad program, *Science and Society*, where six chapter members taught kinesthetic science lessons at Rwandan primary schools. In addition, our chapter has applied for an ACS Student Inter-Chapter Relations Grant for a Demo-palooza: A Celebration of Chemistry. Mentoring K-12 students not only has enriched their lives, but it has encouraged us to actively contribute to society as chemists.

UPLC-TQMS Analysis of Fatty Acids in Ancient Pictographs

Sergio Ivan Perez Bakovic
Faculty Mentor(s): Karen L. Steelman

In order to identify the organic constituent of ancient painted murals in southwest Texas, our laboratory is developing a chromatographic method to determine whether fatty acids were used as binders and/or vehicles. Modern paints samples made with deer bone marrow, yucca root, and mineral pigments mimic ancient paints. To determine how different radiocarbon sample preparation methods affect fatty acid levels, these modern paint samples were subjected to acid-base-acid and base washes, as well as a control of no pretreatment. Fatty acids were extracted with a cholorform:methanol solution in an ultrasonic water bath prior to ultra performance liquid chromatography with a triple quadruopole mass spectrometer detector. Levels of myristic, palmitic, and stearic acids were above method detection limits for all paint samples and treatments. No statistical difference has been demonstrated among pretreatment methods. The results of this experiment suggest that for the analysis of fatty acids the different pretreatment methods do not affect measured levels.

Surface Enhanced Infrared Absorption on Elongated Nickel Nanostructures

Will Henry and Kyle Barker
Donald Perry

The goal of this research was to develop optimal nickel metal nanoparticles (MNPs) for application in biological, medical, catalytic, environmental, and nano-technological research by using surface-enhanced infrared absorption spectroscopy (SEIRA) and surface-enhanced Raman spectroscopy (SERS). MNPs of varying dimensions were formed by oblique angle deposition (OAD) through metal evaporation in vacuum onto CaF_2 substrates at grazing angles ranging from 75^0 to 80^0. These MNPs were characterized with AFM and SEM microscopy as well as UV/Vis-NIR spectroscopy. As a result of OAD, nickel tended to form elongated metal nanostructures at intermediate metal exposures. A monolayer of *p*-nitrobenzoate ion was deposited onto the MNPs to determine the degree of vibrational enhancement in SEIRA. Elongated nickel nanostructures had SEIRA enhancement factors up to x20.

A Photchemical Valine Radical Precursor

Daniel Shrum
Faculty Mentor(s): Nolan Carter

Radicals are produced in biological settings by ionizing radiation as well as endogenous mechanisms related to metabolism. Such radicals can result in damage to biomolecules such as

proteins. Radical damage pathways often involve a complex sequence of reactions initiated by reactive oxygen species such as hydroxyl radical which react by hydrogen atom abstraction to produce protein-centered radicals. Direct study of this process is complicated by the fact that hydroxyl radical reacts with amino acids at multiple sites, leading to many protein-centered radicals. To facilitate the study of this type of reaction pathway, we have synthesized precursor molecules that produce specific amino acid radicals upon exposure to UV light. These radicals serve as models for radicals formed within a protein. In the present work, a tertiary valine radical precursor has been synthesized via reduction of an oxime derived from the corresponding a-oxoester. Preliminary photolysis experiments indicate that this compound generates the desired radical upon photolysis.

Computational Investigation of the Polymerization of Phenylacetylene by Rhodium Scorpionates

T. Ryan Rogers
Faculty Mentor(s): Richard M. Tarkka, Patrick J. Desrochers, and Charles Edwin Webster

Trispyrazolylborate ligands (TpR), also known as scorpionates, have a long and rich history. The sterics and electronics of TpR can be tuned by varying the R substituents. Rhodium-scorpionate complexes catalyze the polymerization of acetylenes. More recent work from our laboratory has focused on anchoring variants of Tp catalysts on resin supports, in an effort to create recyclable heterogeneous catalysts. We will present our findings on the exploration of various mechanistic pathways of phenylacetylene polymerization by TpRh(cod) catalysts. Our results are also used to aid in the design and development of heterogeneous-supported catalysts with novel TpR analogues.

Decomposition Pathways for a Super Greenhouse Gas: Reactions of SF_5CF_3 with $Cu^+(^1S,^3D)$

Christopher M. Church, Xavier S. Redmon, and Benjamin A. Scheuter
Faculty Mentor(s): William S Taylor and Jerald M. Manion

Reactions of the potent greenhouse gas SF_5CF_3 with both ground and excited states of Cu^+ were carried out in a selected ion drift cell apparatus. Copper ions were prepared in a glow discharge utilizing Ne as the working gas. Analysis of these ions using ion mobility mass spectrometry (IMS) indicated the presence of both $Cu^+(3d^{10})$ and $Cu^+(3d^94s^1)$ configurations. Subsequent analysis indicates that the $3d^{10}$ configuration consists of $Cu^+(^1S)$ exclusively whereas the $3d^94s^1$ configuration is composed primarily of $Cu^+(^3D)$ with small contributions from $Cu^+(^1D)$. State-specific product formation in reactions of these ions with SF_5CF_3 was determined using IMS along with the known energetic requirements for product formation. These experiments reveal that Cu^+ excited states initiate fragmentation of SF_5CF_3 to yield SF_2^+, SF_3^+, SF_5^+ and CF_3^+. The energetics associated with the formation of these ions suggest that molecular Cu-containing

products must also be formed in all cases, indicating that the governing reaction mechanisms are more complex than simple dissociative charge-transfer. $Cu^+(^1S)$ exhibits adduct formation exclusively, but IMS experiments indicate that an initial association complex of low mobility undergoes isomerization within the drift cell to yield a second adduct structure of higher mobility. Density functional calculations carried out at the aug-cc-pVTZ level predict that a number of stable singlet adduct structures occur.

Evaluating the Effectiveness of Supported Nickel Scorpionates to Select for Specific Amino Acids

Julie B. Davis
Faculty Mentor(s): Patrick Desrochers

The resin-supported boron-scorpionate ligand, KTp' (Tp'= {HB(resin-Benzotriazole)(pyrazolyl*)$_2$}), readily binds nickel(II) as a tridentate chelate from simple salts in methanol, signified by a green coloring of the beads *(Inorg. Chem.* **2011** p.1). These nickel coordination complexes demonstrate significant histidine affinity under mildly basic conditions. With triethylamine present, the individual selectivity of Bead-Tp'NiNO$_3$ has also been tested for other amino acids (AA = serine and lysine) using ^1H NMR peak integration in which amino acid signals were integrated relative to an internal standard (13% v/v CH_2Cl_2 in CCl_4 sealed in a glass capillary). For each trial, the Bead-Tp'Ni(His)$_n$ complex produced a noticeable and consistent bleaching of the green color. Re-addition of $Ni(NO_3)_2$ to bead-Tp'Ni(His)$_n$ consistently regenerated the green color. To confirm that the changes in the histidine spectrum were solely due to bead uptake of the His, the effect of free nickel(II) on free His was tested as a control experiment by ^1H NMR. Bead recyclability for all testing has remained consistent in this work. The testing of Bead-Tp'NiNO$_3$ for selectivity among various nitrogen-rich amino acids should expand the utility of this established scorpionate class of ligands to broad applications of amino acid selectivity for protein sensing and purification.

Synthesis and Characterization of Dynamic Porous Coordination Polymers (DPCPs) Supported by Pyridylaminde Ligands

Ethan P. McMoran
Lei Yang

Absorption and storage of small molecules, such as H_2, N_2 and CO_2, by dynamic porous coordination polymers (DPCPs) have attracted considerable interest due to the high selectivity and efficiency of these materials. In our effort to discover the new generation of DPCPs, we synthesized a serial of pyridylamide ligands functionalized with multiple donors, which are expected to significantly impact the coordination properties to provide different structural features of materials. Recently, various coordination polymers/clusters with different nuclearity supported by these pyridylamide ligands have been prepared and characterized by X-ray

crystallography, IR, Mass spectrum and elemental analysis. The interesting structural and spectroscopic features of these compounds will help us obtain a deeper understanding on ligand design and polymer construction, which are major contributors for adsorption properties of DPCP materials.

Polymerization of Phenylacetylenes by Rhodium(I) Scorpionate Catalysts

Laney M. Mason
Faculty Mentor: Richard M. Tarkka

Tp'Rh(cod) and Tp*Rh(cod) are catalysts containing a rhodium ion and a boron centered scorpionate ligand. The distinction between these two catalysts is a slight structural difference on one of the heterocyclic rings: one of the dimethylpyrazole rings of the tris(pyrazolyl)borate ligand, Tp*Rh(cod), is replaced by a benzotriazole ring to make Tp'Rh(cod). The goal of this study is to investigate how effective these two rhodium(I) scorpionate catalysts are in the polymerization of phenylacetylene and similar monomers. Kinetic experiments were run using ^{1}H NMR spectroscopy. Results suggest that the initial rate of polymerization is first order until about seven percent of the monomer, or 36 units, has been polymerized. At this point there are other factors effecting the polymerization that cause it to level off.

Microwave Synthesis of a Resin-Supported Chelate

Adam Pearce
Faculty Mentor(s): Patrick Desrochers

A new resin-supported scorpionate chelate has been synthesized using microwave methods. This chelate has been shown to effectively bind various transitions metal ions, including chromium(III), rhodium(I), and copper(II), leading to functional heterogeneous complexes for each. The chromium(III) cases were characterized by electronic spectroscopy and show active ligand substitution chemistry, including reversible ammonia bind and cyanide coordination, The resin-supported rhodium(I) case is catalytically active toward the production of poly-phenylacetylene oligomers; a reaction whose progress was monitored by electronic spectroscopy. The sustainability of this rhodium(I) catalyst was demonstrated by repeatedly using the same resin-supported catalyst in five successive polymerization reactions. The copper(II) system gives clear EPR and electronic spectroscopic signatures. The redox activity of this system is also being tested; under certain conditions the copper(II)-chelate complex has shown the ability to be reduced by ascorbic acid. Because of the aggressive metal-coordination exhibited by this resin-supported by this resin-supported chelate, it has promise for extracting targeted lanthanide metal ions from natural and remedial sources.

Computer Science

A Look into Half-Against-Half Support Vector Machine Classification using Hierarchical Clustering

Christopher Rhodes, Erica Sheffe, David Morgan
Faculty Mentor(s): Victor S. Sheng

Supervised machine learning has many techniques, including Naïve Bayes, J48 Decision Trees, and Support Vector Machine (SVM) classification. The goal is to learn a function based on classified training data, and to maximize the classification accuracy of related testing data. Classification can become increasingly more difficult when the dataset used contains more than two classes. Popular classifiers of such multi-class datasets are the two following techniques: One-Against-All (OAA) and One-Against-One (OAO). In this paper, we implement and analyze a similarly proposed algorithm called Half-Against-Half SVM Classification (HAH), which uses Hierarchical Clustering and Support Vector Machines to form a naive decision tree of classifiers. We show that the Half-Against-Half method can produce similar or better results to One-Against-One and other contemporary, popular classifiers.

A Multi-label Classification Techniques for Reconstructing Missing Boolean data

James Lemon, Xiaoqin Fu, Daniel Woo
Faculty Mentor(s): Victor S. Sheng

Many data-sets generated are missing values because of incomplete collection methods or imperfect transfer methods. Missing values reduce the quality of a data-set by limiting the types of analysis that can be completed on the data-set and a limited understanding of the sample. Many times the value of a piece of missing data is implied in the rest of the data, and can be uncovered using statistical methods. By reconstructing the missing data, the quality of incomplete data-sets can be improved before further analysis. Our experimental results show that that we can impute 80% of the values in data-sets used in our experiments at a success rate measurable better than guessing.

Analysis of Weighed Naive Bayes Classification

James Stamps, Eli Tallman, T J Hoover and Thomas Marchand
Faculty Mentor(s): Victor S. Sheng

Naive Bayes is an effective classification algorithm used throughout academia and industry for binary classification of various datasets in which the variables constituting an instance in the dataset are considered independent. Typically, no local weighting is used in combination with Naive Bayes when conducting analysis. In the following experiments, Gain Ratio, Hill Climbing, and Markov Chain Monte Carlo weighting algorithms are applied to the analysis of the data sets. These weights cause a marked increase in the predictive ability of the Naive Bayes classification algorithm in the general case, although certain weighting algorithms have the potential to cause a decrease in predictive ability in specific datasets.

Bluetooth Controlled Robot with Object Avoidance

Nathan Hotchkiss, Jared Wood, Elvis De Abreu, Hai Le, Edgar Castro, David Morgan, Daniel Macha
Faculty Mentor: Dr. Yu Sun

Nowadays, robots become a very important factor of human kind. Staring from the ancient world, until today, robots have being developed nonstop. Motivated by robot's importance, in the project, we study and develop robotic systems. There are several different platforms for developing a robotic system and each with different benefits and needs. Since Arduino is a versatile platform with many options, we selected a robot kit - a "Rover" which is a large format Arduino Uno board with a motor and tank-style track system. We have developed two functions on this rover: 1) Obstacle Avoidance; 2) Bluetooth Control via Android Phone App. The experimental results demonstrate that our rover is able to detect obstacles accurately and can find alternative paths automatically to avoid obstacles. In addition, by using android cell phones, we can easily control the movement of our rover remotely though Bluetooth. Regarding to the future work, we will improve the speed of obstacle detection and avoidance, and enhance remote control functions on cell phones.

Large-scale Multi-class Learning

Kyle Eichelberger, Hai Le, Alex Yu, Andrew Register
Faculty Mentor(s): Victor S. Sheng

Analyzing large-scale class projects is never a simple task, and the difficulty increases exponentially when there are multiple of classes. Due to the limitation from the Internet, in this research, our group analyzed four large-scale multi class datasets. One of them has more than one hundred classes. The other three are mid-sized datasets with number of classes between twenty and eighty. We record values to show how all the datasets behave through three methods: one

against one, one against all, and exhausted correction comparison. Since this is a research project about large-scale multi-class, it is impossible to analyze the data by hand. As a result, we use Weka, a popular machine learning software package, to run the datasets. The experiments done here are interesting, although not comprehensive. While not able to show any real consistencies within the context of these experiments, these results do present some serious questions and ideals that may lead to future experimentation. Future results will include the rest of the planned experimentation, and perhaps some ideals for optimization.

LEGO Mindstorms EV3 Transformers

Guofu Huang, Jared Wood, Elvis De Abreu, and David Fink
Faculty Mentor: Dr. Yu Sun

LEGO MINDSTORMS Education EV3 is the newest robot making kit of LEGO MINDSTORMS series, which is cooperatively developed by MIT and LEGO. In this project, we investigate this educational robot kit by making robots with sensors and motors. The purpose of this project is to use Lego MINDSTORMS series as an educational tool to spark kids' curiosity and stimulate their learning interest in science and engineering. So far, our group has built several robots in different shapes, like Gripper, Spider and Ev3rstorms. The functions we have developed for our Lego robots include object avoidance using infrared sensor, voice control with app, remote control using wireless phones, following a colorful path with a color senor. In our outreach activities, like CNSM science nights, we demonstrated our Lego EV3 robots to kids. It turns out that Lego EV3 is an excellent tool in educating young minds on robotics.

Voice Controlled Dancing Robot

Donnie Turner, Erica Sheffe, Clifford Tawiah, Sachiko Oshio, Olesya Derkach, Byungkyu Kang, Valerii Dychok, Doga Demirel
Faculty Mentor: Dr. Yu Sun

Voice control over devices is useful in various situations. For example, it can be used by disabled people to control tools or machines which they have to use. Voice control can make people's lives easier since it does not require any extra work like pushing buttons to make machines move. Therefore, voice controlled interaction is a promising research field. In this project, we have investigated voice control with an Arduino robot and developed various voice commands to control our robot's movement. The robot not only moves by voice commands to any direction, but it also makes some special movements, such as spin, slow-down, speed-up, and so on. Currently, we are working on making the robot perform more complicated movements like dancing and playing music. So far, we have implemented the dancing and music features separately. The next step is to make the robot play music while dancing. If the robot can recognize the command, perform a dance, and produce sound, it can be used in situations that need bidirectional communication between people and the robot.

Overall Effectiveness of Naïve Bayes Classifier When Combined With Locally Weighted Learning

David Latham, Elvis De Abreu, Edgar Castro, and Donnie Turner
Faculty Mentor(s): Victor S. Sheng

Weka can be used to check for the effectiveness of the Naive Bayes classifier given different operating conditions. Even though the Naïve Bayes is simple and exhibits good performance on a variety of learning problems, it has a weakness that researchers have been trying to overcome; the attribute independence and in this way, improve the performance of the algorithm. The focus of the test is to see if there is any improvement over singular Naive Bayes when it is applied using locally weight learning. For each dataset, Naive Bayes will be applied singularly and then the dataset will be processed again but locally weight learning to be combined with Naive Bayes. It has been determined that using only Naive Bayes is effective to with high accuracy rating, adding LWL to the data will always perform better with an increase of the accuracy rates up to 4%. Using singular Naive Bayes with the help of locally weighted learning will improve the accuracy of any dataset making the results more accurate.

Mathematics

Should You Get a Degree?

Tim Smith, Hung Lu, Robert Habimana
Faculty Mentor: Long Le

With our research project we will be examining individuals with GEDs, Bachelor degrees, and PhDs, and then see how they differ economically at the state and national levels. There are two main studies we would like to examine from this research; how long does it take for people with degrees to earn equal profit to those with GEDs and is it worth it to get a PhD, and if so, where should you look for work as an Arkansan?

A Model for Giving up Smoking

Seth Bloomberg, Tianpeng Sun
Faculty Mentor(s): Long Le

Nearly 9 out of 10 smokers started smoking by age 18. In 2012, 23.3% of high school students used tobacco products. These include cigarettes, cigars, hookah, snus, smokeless tobacco and electronic cigarettes. If smoking persists at the current rate among youth today, about 1 in 13 Americans aged 17 years or younger are projected to die prematurely form a smoking-related illness. Our goal for this project is to analyze and solve a system of ordinary differential equations to determine the long-term behavior of smoking habits with a high school system.

IPO Financial Analysis for Potential Investment

Jason Moix, Bryce Nicholson
Faculty Mentor(s): Long Le

While stock prices often seem random, a major indicator for a stock's current and long-term value is the assumption of the potential rise and fall of company profit levels. By examining the trends of a company's cost and revenue over time, we can create a model for future profit. Through the use of one-variable optimization, we can predict with reasonable uncertainty, what the estimated maximum profit level will be and the estimate time at which it could occur, indicating stock potential and indicating an estimated optimal time to release stocks, respectively.

Physics and Astronomy

Resonance Lab for High School Students

Kenny Matz
Faculty Mentor(s): Dr. Carl Frederickson

A lab activity has been developed to teach high school students about harmonic resonance. It utilizes an average laptop PC and a few other readily available components. The project includes a lesson plan and a set of experiments that demonstrate harmonic resonance in open-ended tubes. A particular goal of this project is to keep the experimental materials and the cost at a minimum. The experiment only requires a PC laptop, analyzer software, an external PC speaker, microphone, and pvc pipe. The experiments will help students visualize the harmonic frequencies associated with the tube. Students will be able to compared calculated values for the harmonic frequencies for different length tubes to measured values. In addition, it will provide them an opportunity to use a frequency generator and spectrum analyzer. A familiarity of these devices will be beneficial to them in their college physics courses. The main difficulty in this project was finding software that can be used on the average laptop PC that is both appropriate and adequate for running resonance experiments. The software would be required to act as a signal generator and a spectrum analyzer. It also must be relatively easy to use and most importantly, free. Several different programs were downloaded, installed, and tested. A few of those programs met all of the software requirements. After performing "field tests" using each of the programs, the best was selected and a full implementation of the experiment was performed. The chosen software performed well throughout the experiments, thus confirming that an inexpensive, readily available analyzer program can be used with an ordinary laptop PC, within the classroom or at a students' home, to produce meaningful experimental results.

X-Ray Fluorescence and Moseley's Laws of X-ray Radiation Spectra

T. Ryan Rogers, P. Hunter Ward, Nicholas L. Frederickson, Anthony D. Mitchel
Faculty Mentor(s): Dr. Rahul Mehta, Dr. Azida Walker

X-rays were produced and directed toward a variety of samples, both elemental and composite, causing energy excitations in the atomic electrons of the samples. Subsequent relaxation of the excited electrons emits one or more x-rays, whose energy is unique to radiation from samples of the same element. In this way, detecting the characteristic x-rays an irradiated sample emits allows one to determine a sort of "fingerprint" of any element studied. These x-rays were detected and their energies recorded for many different samples, which values are corroborated by literature standards. K, L, and M-shell transitions are observed. Having collected a small library of the characteristic x-rays of several elements, the composition of two "unknown"

samples is also determined. In addition, Moseley's empirical laws for the relationship between atomic number and the energies of emitted x-rays are verified.

Synchronization Limits of Chaotic Circuits

Christopher M. Church
Faculty Mentor(s): Stephen R. Addison

Through system modeling with electronic circuits, two circuits were constructed that exhibit chaos over a wide ranges of initial conditions. The two circuits were one that modeled an algebraically simple "jerk" function and an RLD circuit where the diode was reverse-biased. Using simulation data from other experiments, the chaos and bifurcation plots of the concrete circuit were verified. Identical circuits were then built containing variable components and coupled to their original, matching circuits. The variable components were used to sweep a wide range of conditions to establish the desynchronization parameters and the range of synchronization.

Effect of Heat on Ferrofluids

Benjamin Thines
Faculty Mentor: Stephen R. Addison

The purpose of this experiment is to determine the effect, if any, of heat on the phase change in ferrofluids. A ferrofluid undergoes a phase change, which includes a viscosity change when under the influence of a electro-magnetic field. In this case a ferrofluid will be heated to temperatures above room temperature and exposed to an electro-magnetic field of a known magnitude. The phase changes will be noted and the data will then be compared from varying different temperatures. In order to do this the ferrofluid must be safely and reliably heated. A length of coiled copper pipe is being employed to serve as a heat exchanger between a heat source. Both ends of the pipe will terminate in the reservoir area where the electro-magnetic field will be deployed. Convective currents in the ferrofluid circulate the fluid. Temperature probes deployed both near the termination points of the copper pipe and physically submerged in the ferrofluid provide accurate measurements of the Fluid temperature. Data will be analyzed against the control temperature, room temperature. Correlations between temperature increased and phase change will be analyzed.

Determining Black Hole Mass of Active Galactic Nuclei Using FWHM of the Hβ Emission Line and Luminosity Relations

Jeremy Jacobs and Steven Clark
Faculty Mentor: Debra L. Burris

The Narrow Line Emission from an Active Galactic Nuclei contains the Balmer Hβ emission line. These lines are believed to come from material further from the central black hole. The Hβ line can be used to determine the velocity of the gas. The luminosity of the black hole can be determined by applying the extinction correction to the spectral files. The extinction correction accounts for the amount of light that our own galaxy absorbs, giving the true luminosity of the AGN. With both the velocity of the gas and the luminosity, the mass of the black hole can be determined. We have recently begun a project using IRAF to measure the FWHM of the Hβ line for a group of AGN selected by the research group of J. Kennefick at the University of Arkansas. This will provide an independent mass determination for use as they seek a correlation with spiral galaxy pitch angle and black hole mass.

Project Euler in Three Languages

James Palmer
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Project Euler is a series of computational problems intended to be solved using a programming language. There are 465 problems at the time of this writing, with a new problem published every weekend. Here, I demonstrate the approach to solving these problems in three distinct programming languages: Visual Basic.NET, Python 3, and C++. The advantages and disadvantages of each particular programming language will be highlighted. A write up in LaTeX served as the report and conclusion to each problem. Finally, I discuss how Project Euler is an invaluable learning tool that both encourages critical thinking and generates an excitement for problem solving.

Acoustic Properties of NASA Flight-Approved Materials and other Testable Samples

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Minimizing excess noise aboard manned space vehicles continues to be an active concern for NASA's Johnson Space Center. Excess noise, especially within a confined space, can affect work productivity, clarity of communication, as well as resting habits. One means of changing a location's acoustic properties, whether it is a space vehicle or a classroom, is by the use of sound absorbing materials. Understanding the acoustic properties of such materials can lead a better

acoustic environment. In relation to many provided acoustic foams and felts, this project seeks to quantify three frequency dependent quantities; namely, the absorption coefficient, acoustic impedance, and complex wave number values. These are obtained by utilizing an impedance tube in which two microphones simultaneously measure the forward and backward components of generated plane waves within the tube. Data analysis of the complex microphone response measurements is conducted in two ways; one which follows a featured procedure in an ASTM International standard and another which is derived to accommodate for a one inch air gap in the experimental setup. In order to aid in the analysis of these complex quantities, Python code templates are created to read in test data, generate acoustic plots, and also validate prior work with past samples in which the data was evaluated using various formatted equations within Microsoft Excel. Organizing these results can lead into the discussion of how to specifically arrange and utilize the materials to both maximize their acoustic performance based upon a material's density and minimize excess ambient noise on manned space vehicles.

H-alpha Line Variability of Be Stars

Ryan Boswell
Faculty Mentor: Dr. Scott Austin

My research includes the study of the H-alpha line of certain Be type stars to learn about the envelope of gas that surrounds the stars. It is not well known how these gas envelopes form or the mechanics of the gas itself. I have used the UCA fiber fed spectrograph in conjunction with the Image Reduction and Analysis Facility (IRAF) software to study the gas envelopes. The IRAF software takes collected data and reduces it down to a useful form to properly extract data relevant to the H-alpha emission line. Seeing how the H-alpha line varies over time through spectroscopy gives vital information on the formation and the structure of these structures. Since Dr. Austin has been collected data for nearly a decade now, I am able to compare my research to his previous work to see some of these changes.

The Rate of Energy Loss of Alpha Particles

Ashley Cotnam, Gerard Munyazikwiye, and Xavier Redmon
Faculty Mentors: Azida Walker and Rahul Mehta

The range of alpha particles through copper foil was measured using a multichannel analyzer (MCA). The experiment evaluated the relationship between the range of alpha particles emitted from an Americium-241 source and the thickness of the medium (copper) it entered. Results showed that as the thickness of copper increased, the range of alpha particles passing through it decreased. This indicated that the alpha particles lost energy via electrostatic interactions with the medium through which they passed, and that the total energy lost was the accumulation of multiple interactions undergone by the alpha particles as they passed through the medium.

Observation of Gamma Gamma Coincidence

Jeremy Jacobs, Tanner Feeler, Doug Roisen, and Lucus Ratz
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When Na-22 decays it has a 99.95% chance that it will emit a positron. When a positron is emitted it undergoes an annihilation reaction with an electron, which releases two gamma rays. These gamma rays will be in coincidence with one another. The purpose of this experiment is to verify these gamma rays are coincident to each other using two detectors, delay amplifier, and a gate. By changing the angle in which the detectors are related to each other relative to the source there is a clear maximum in the intensity of the desired gamma rays to verify that they are coincident.

Detection of Transiting Exoplanets Through a Small Aperture Telescope

Robert A. Arnold

Faculty Mentor: Scott Austin

Exoplanets capture the imagination of the public, give scientists ideas on planetary formation, and their future study may one day answer questions on the existence of life elsewhere in the universe. One method used to detect exoplanets is known as the transit method. It involves observing the change in a star's brightness caused by an orbiting planet. As an exoplanet orbits its host star it may pass between the star and Earth and cause a decrease in brightness which can be detected. This dip in brightness is very small and thus difficult to detect. It had been thought that the transit method required the use of large aperture telescopes and would be beyond the abilities of smaller observatories. Recent papers by researchers such as Morris (2011) and Sergison (2013) have demonstrated procedures used to detect transiting exoplanets with small aperture telescopes such as the one at the University of Central Arkansas. The purpose of this project is to detect the transits of known exoplanets through differential photometry by implementing the procedures explained by Morris and Sergison. Further discussion is given to the possibility of meaningful contributions to the study of exoplanets from researchers with similar equipment.

Effects of Microgravity and Radiation on Elastic Modulus of Rat Femurs Using 3-Point Bending

Otis Perkins

Faculty Mentor(s): Dr. Azida. Walker, Dr. Rahul. Mehta, Dr. M. Dobretsov, Dr. P. Chowdhury

Studies have shown that exposure to microgravity results in the loss of bone mass. This study aims to determine the variations in elastic modulus of rat femurs under microgravity conditions and radiation exposure. Data obtained here will serve as a model for the effects of space-flight on bones. Microgravity was simulated by hind limb suspension of the rats via the tail for two weeks. Radiation exposure occurred during the same time as suspension with a dose 10 grays given over the same time period. The animals were then sacrificed and the femurs were surgically extracted

and cleaned of the adhering soft tissue. The experimental technique used to attain elasticity began with the design and development of an apparatus for securing the bones at both ends while a force was exerted upward near the center of the shaft section of bone creating three-point bending. Measurements were recorded for the mechanical force on the bone as a function of displacement for the stress point and applied to the Young's Modulus equation to calculate elasticity. The data shows that microgravity does affect the elasticity of the bones. While more experiments will be needed to fully understand the effect of space travel on humans; the data presented here will be a useful model for the effects of space flight on bones. This model can then further be used in the design of experiments to help improve our understanding of the human body under microgravity conditions.

RBS – Kinematical Scattering and Angular Dependence

Dawson Long, Cruz Segura, Forrest McDougal, Lawrence Benzmiller,

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Faculty Mentors: Rahul Mehta, Azida Walker

In this experiment, the scattering of Hydrogen ions by Quartz, Silicon, and Gold-Silicon foils was measured. A Hydrogen beam produced by a particle accelerator bombarded targets made of thin films of Quartz, Silicon, and Gold-Silicon. A detector was placed at 160 degrees to the target and observed the counts of deflection from the various metals. While holding the beam energy of 2 MeV, the angle at which the detector was placed, and the type of beam constant, the Kinematical Scattering factor K was calculated. Once calculated, the value was compared to the expected value of the ratio of the final and initial energies. In addition, a Helium beam was scattered from a thin Gold-Silicon foil. The angle of the detector was varied while holding the beam energy at a constant 2 MeV. From this, the Rutherford elastic scattering cross-section factor for each of the angles was calculated. The experimental cross-section factors were then compared with accepted cross-section factors at those angles. The data shows a clear correlation between the counting rates and mass of the targets, as expected. In addition, the data illustrates the correlation between the angle of the detectors and the cross-section factors. The experiment supported the theoretical equations for the Rutherford scattering cross-section and angle dependency.

Interdisciplinary

Determining Individualistic Vocal Characteristics of *Panthera tigris* and Implications for Acoustic Monitoring of In-Situ Populations

Courtney Elizabeth Dunn
Faculty Mentor(s): Mary Victoria McDonald, Ben Cash, William Slaton

Our aim is to determine if unique acoustic patterns exist among *Panthera tigris* living in controlled circumstances and if males can be discriminated from females based on their calls. The hypothesized complexity of vocalizations will potentially enable a vocal "fingerprint" to be developed for individuals, which in turn will allow for vocal monitoring as well as censusing of in-situ populations using microphone arrays placed strategically over the tigers' home ranges. Determination of sex-specific vocal differences, as well as stage in reproductive (estrus) cycles of females, also has the potential for estimating representation of breeding populations.

From May to September 2013, 38 tigers (22 females, 15 males) were observed and recorded at three study sites in the United States. Recording sessions occurred from approximately dusk to dawn (17:00 to 09:00) using the Songmeter SM2 Platform in 16-bit full-spectrum uncompressed .WAV format. Targeted vocalizations included prusten, subroars, and long-distance calls which range from close-contact vocalization to communication over many kilometers. Furthermore, daily weather conditions (e.g. barometric pressure, humidity) were recorded to analyze any climatic effects which may impact our ability to discriminate individuals.

Raven Pro spectrogram outputs were utilized to determine vocal category, vocal period, and more specific acoustic measures, including but not limited to duration of the period, duration of inter-call intervals, duration of each call, duration of the first, middle, and end call within a period, number of calls within a period, and minimum and maximum fundamental frequencies. Non-metric multidimensional scaling (NMS) determined significance, which relates to the chance of identifying an individual based on a call. From preliminary work, detectable differences between common calls of individuals have been observed. Further analysis of their vocalizations is predicted to reveal complex vocal differences.

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