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COLLEGE OF NATURAL SCIENCES AND MATHEMATICS

UNIVERSITY OF CENTRAL ARKANSAS

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MATHEMATICS AND COMPUTER SCIENCE BUILDING

1st FLOOR

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BIOLOGY

Spatial and temporal patterns of fish assemblages in a floodplain wetland mosaic of the Mississippi River

Lainy Burkard
Faculty Mentors: Reid Adams and Ginny Adams

Floodplain habitat connected to the Mississippi River has declined and is particularly rare in upper and middle regions of the basin. The Missouri Department of Conservation recently purchased a tract of floodplain habitat in Scott County, Missouri having a diversity of aquatic areas (e.g., lowland stream, floodplain pond, and beaver pond) that periodically connect with the Mississippi River. Our objective was to survey fishes found in the study area and to examine variation in fish assemblage structure due to habitat and season. During spring and fall of 2006 and 2007, fishes were collected by seining, overnight sets of fyke nets, and gill nets. We collected a total of 16,633 fishes, comprised of 35 taxa. Resident fish assemblage composition was highly represented by native species of lowland faunal regions (e.g., *Aphredoderus sayanus, Elassoma zonatum, Amia calva, Lepomis gulosus,* and *Etheostoma gracile*). Assemblage structure varied in habitats sampled. A beaver pond, characterized by greater depths and presence of submerged vegetation contained the most unique assemblage. Species richness tended to be higher during spring, and seasonal patterns were influenced by flooding and summer dry periods. Riverine species (e.g., *Ictiobus*, *Moxostoma*, *Morone*) were only present in the wetland complex following flooding from the adjacent Mississippi River. The data suggest the floodplain area continues to support fishes typical of complex, floodplain habitat that periodically connects with the Mississippi River. Planned restoration activities by the Missouri Department of Conservation may further enhance the value of this floodplain area to the Mississippi River ecosystem.

Leaf Temperature, Photosynthesis, and Gas Exchange in Developing Sunflower Leaves

Toni Clark
Faculty Mentor: John Choinski

Plants dissipate heat by emission of long wave radiation, convection, and most significantly, in the process of transpiration (Fitter and Hay, 2002). Optimizing temperature is critical for metabolic processes, especially photosynthesis. Recent research (Snider *et*. al 2007, in press) suggests that springtime optimum temperature range for photosynthesis is higher and stomatal conductance lower in young *Rhus glabra L.* (Anacardiaceae) leaves in comparison to mature leaves. This trend was absent when measurements were taken during summer and fall suggesting that higher temperatures in young spring leaves may promote temperature-sensitive processes. Prior to Snider *et*. al 2007, the phenomena of elevated spring temperatures in immature leaves was unknown; here we investigate the possibility that elevated spring time temperatures in young leaves is not restricted to sumac trees. To test this hypothesis, we reared three cohorts of sunflowers, *Helianthus annuus L.* (Asteraceae), under controlled environmental conditions and measured: leaf surface temperature, stomatal conductance rates, actual quantum yield, leaf surface area, leaf perimeter, total chlorophyll, and the number of stomata/mm^2. Preliminary results showed that young sunflower leaves are warmer, have lower stomatal conductance, lower actual quantum yields, and chlorophyll content than do mature leaves. We further showed that temperature optima determined and using chlorophyll fluorescence were higher for young leaves than mature leaves. We suggest that the higher temperatures observed in young leaves compared to more mature leaves may be a common a phenomenon in plants resulting in enhanced leaf expansion in the spring and pre-adaptation for the higher temperatures to come later in the growing season.

Antibody Heavy Chain V(D)J Rearrangements In Mercury-Treated Vs. Control A.Sw Mice

Heather J. Clarke and Britne Kuykendall
Faculty Mentor: Ben Rowley

The A.SW congenic strain of mice has been used as a model of chemically induced autoimmunity for three decades. Subtoxic mercuric chloride ($HgCl_2$) treatment induces a defined autoimmune syndrome in these mice, characterized by production of antinucleolar antibodies (ANoA) of the IgG1 and IgE isotype. Lacking from the literature on this model is a study of which specific antibody heavy-chain gene segments utilized within mature, circulating B-cell receptors (BCR's) are positively selected out of the B lymphocyte repertoire by mercury treatment. This study utilized a nested polymerase chain reaction (PCR) approach on sorted individual cells from treated and sham-treated A.SW mice. This method was followed by sequence analyses of gel-purified products, to identify individual V(D)J gene segments utilized in B lymphocytes from treated and non-treated animals.

Reproductive Ecology and Laboratory Spawning of the Western Sand Darter, *Ammocrypta clara*: Observations of Previously Undocumented Behavior

Luke Driver
Faculty Mentor: Ginny Adams

A reproductive life-history study is currently being conducted on the Western Sand Darter, *Ammocrypta clara,* in the Black River system in northeastern Arkansas. While much is generally known about darters within the genus *Ammocrypta*, limited research has been conducted specifically dealing with the Western Sand Darter. Gravid females and mature males were collected from the Current, Strawberry, and Black rivers from June to mid September 2007, indicating a late and protracted spawning season. Reproductively mature specimens were collected in late August for laboratory observation and spawning behavior was observed on 28 August 2007. Males and females were observed undulating and vibrating vigorously in corners and along the side of the tank, creating depressions in the sand substrate. Spawning events varied in the number of individuals participating, from one male and one female, up to 8 individuals of unknown sex ratios. Fertilized eggs were found in the corners of the tank and buried singly within the sand. Eggs were collected from the aquaria on 29 August (n=58) and 30 August (n=31). Spawning behavior, including group or paired vibrations and depression building, continued through early September but no eggs were found after 30 August. During the observation period, fish remained buried in the sand except in crepuscular periods (dusk and dawn) with more activity occurring at dawn compared to dusk. Most individuals came to the surface within 5 minutes of the application of light (to simulate dawn) and remained active for approximately one hour before burying in sand. Feeding was not observed during the spawning period, and active feeding did not resume until several weeks after spawning. In addition, post-spawn adults were active diurnally (during daylight hours). These observations indicate an interesting ecology and behavioral life history that is unique to Sand Darters and represent the first documentation for Western Sand Darter.

Contaminant Concentration Analysis in Cave Streams Utilized by Grotto Sculpin (*Cottus carolinae*) in Perry County, Missouri.

J. Tyler Fox
Faculty Mentors: Ginny Adams and Karen Steelman

Recent studies have employed polar organic chemical integrative samplers (POCIS) and semipermeable membrane devices (SPMDs) to assess contaminant levels in aquatic ecosystems. The current study is among the first to use these sensitive *in-situ* samplers to monitor water quality of subterranean streams. Five streams in Perry County, Missouri, located on the eastern edge of the Salem Plateau Subprovince of the Ozark Plateau, were targeted for analysis. These streams are the only known habitat for the Grotto Sculpin (*Cottus sp., sp., nov.*), a rare hypogean fish allocated to the Banded Sculpin (*Cottus carolinae*) complex, and a species of high conservation concern. Groundwater in karst systems is very susceptible to contamination from

agricultural runoff and leaching or leakage of human sewage and livestock wastes. In Perry County, thin or unconsolidated soil layers and numerous sinkholes allow rainwater to flow directly into many caves without filtration that may otherwise provide remediation of contaminants. As a consequence, water quality can quickly and severely decline with very rapid transmission of pollution from the surface into caves and conduits of the karst aquifer. Contaminants which are suspected to be present in the caves have been shown to alter brain chemical activity and hormone levels in individual organisms, and can cause serious food base reductions in already nutrient-limited cave streams. This study will allow researchers to obtain valuable data on the presence of potentially harmful chemicals in Grotto Sculpin habitat, and provide baseline data for future monitoring efforts. Canisters containing both POCIS and SMPDs will be deployed in five cave streams during spring and summer of 2008. Extracts from exposed samplers will be analyzed for a number of organophosphorous and organochlorine pesticides, in addition to polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers, and several fragrances.

Effects Of Scheduled Burning In Control Of Competition Between Native And Invasive Honeysuckle In Arkansas

Benjamin Frizzell
Faculty Mentor: Katherine Larson

My research investigates the impact of seasonal timing of controlled burns on a native and an exotic species of honeysuckle in Arkansas. Japanese Honeysuckle is one of the most widespread and problematic exotic species in Arkansas forests and forested edges. To control this species, land managers use herbicide treatments and controlled burning. Burning has the advantage of being more selective, killing or damaging species without adaptations to fire, but leaving other more fire adapted species. Japanese honeysuckle responds to fire with a complete top kill, but regrows rapidly from roots and runners, so is at least somewhat adapted to recover from an occasional fire. Although the impacts of fire on *L. japonica* have been studied, no information exists on the impact of fire on the native honeysuckle, *L. sempervirens,* that Japanese Honeysuckle has replaced in many parts of Arkansas. It is possible that *L. sempervirens* is more adapted to fire than the exotic species, and that as fire frequency has decreased in Arkansas, the competitive advantage has gone to the exotic Japanese Honeysuckle. The issue addressed by this study is whether *L. sempervirens* is adapted to more frequent fires that *L. japonica*. Plants of both species were burned in fall, spring, or left as a control. Regrowth of spring shoots from the root stock indicated that for control treatment, *L. japonica* produced significantly more shoots. However, fall burns increased shoot production by *L. sempervirens*, while decreasing shoot production by *L. japonica*. Consequences for managing these two species will be discussed.

Taxonomic distribution and ecological function of girdling by caterpillars of prominent moths (Lepidoptera: Notodontidae)

Carissa Ganong
Faculty Mentor: David Dussourd

Many insect species exhibit a behavior known as girdling: they chew a furrow around stems or leaf petioles, often before ovipositing. Few studies have examined girdling associated with feeding, although investigation of this behavior may provide insights not only into insect foraging ecology, but also plant physiology. The goal of my research is to determine which species of caterpillars in the prominent moth family (Notodontidae) cut girdles, what factors affect girdling behavior, which plant vascular tissues are severed by girdling, and what the function of girdling is. Data collected so far indicate that girdling occurs in at least two distinct branches of the notodontid family. Caterpillars typically girdle in the ultimate or penultimate instar (larval stage), and the frequency of girdling varies between seasons, years, and host plant species, but is not affected by switching larval host plants partway through development. Preliminary data indicate that girdling severs the phloem and cortex. The main question remaining to be answered is whether caterpillars develop more rapidly on girdled leaves than on control leaves and, if so, whether girdling increases leaf quality (e.g. by increasing accumulation of photosynthates or nitrogen) and/or prevents decreases in leaf quality (e.g. by preventing influx of defensive compounds).

Ongoing Development of Transgenic *Arabidopsis* and *Rubus*

Nadine Gates and Tatum Branaman
Faculty Mentor: J.D. Swanson

Transformation is the genetic alteration of a cell resulting from the uptake and expression of foreign genetic material (DNA). Genetic transformation techniques have been in existence for less than twenty years and have already made a huge impact on agriculture. The benefit of transgenic agriculture includes herbicide-tolerant and Bt-crops for pest management, altered ripening/oil content, and increased vitamin levels (Gasser et al., 1989). In Dr. Swanson's laboratory, we are currently working towards the transformation of *Rubus spp* and *Arabidopsis,* both excellent model systems for studying the genetics of agriculturally and economically important crops. *Agrobacterium*-mediated transformation techniques will be used to transform both systems. PCAMBIA, a vector used to produce transgenic plants, combined with a *GFP* reporter gene, will be transformed into *Agrobacterium* and then into the plants via *Agrobacterium* uptake. This technique, however, will be applied to each system in a different way. *Arabidopsis* transformation requires a flowering *Arabidopsis* plant to uptake the new genetic material (contained within the PCAMBIA plasmid in *Agrobacterium*) through its ovules, thus causing the plant to produce transformed seeds. The seeds will then produce transgenic plants. For the transformation of *Rubus spp*, the PCAMBIA vector will be introduced via tissue culture.

Determining Caf4's Function In *Saccharomyces Cerevisiae*

Matt Harvison and Jacob Seiter
Faculty Mentor: Kari Naylor

Mitochondria are the organelles that provide the cell with chemical energy in the form of ATP. Mitochondria have a dynamic, branching tubular structure which is maintained by constant fission and fusion. Any alteration of the fission and fusion process can change the mitochondria structure, potentially resulting in disease due to mitochondria's loss of efficiency. Mitochondrial fission requires three proteins; Dnm1, Fis1, and Mdv1. Dnm1 functions dynamically for fission to take place, Mdv1 is the molecular adaptor between Fis1 and Dnm1, and Fis1 is the transmembrane protein found on the mitochondria where fission will take place. A fourth protein Caf4, has been discovered to be a homolog of Mdv1and also acts as an adaptor between Dnm1 and Fis1, but over-expression results in a lack of fission. This leads us to believe that Caf4 is a negative regulator of fission, and possibly switches positions with Mdv1 for fission to proceed. From our research, we will be using the confocal microscope to better understand Caf4's role in fission. This will be done by observing when Caf4 is found on the fission complex and at what point during fission. If Caf4 is present before the fission event and absent during fission, it will support our belief that Caf4 is a negative regulator.

Alligators (*Alligator mississippiensis*) in Southwest Arkansas: An Examination of Population Structure and Reproductive Traits

Travis Henry
Faculty Mentor: Stephen Dinkelacker

American Alligators (*Alligator mississippiensis*) are found throughout the wetlands of the southeastern United States. Their ecology has been intensively studied in Louisiana, Florida, and other states. From a broad perspective it is apparent that variation in population and reproductive characteristics occurs across the animal's range. Arkansas marks the northwestern range limit of the species and populations have never been studied in detail. Currently, the state is set to begin its second annual Alligator Hunting Season. The harvest quota for this season is based upon Arkansas Game and Fish Commission (AGFC) surveys utilizing the results and models from studies conducted primarily in Florida in Louisiana. It is unclear if these assumptions hold true for populations in Arkansas due to geographic variation. This study seeks to examine population and reproductive characteristics in American Alligator populations at four sites in southwest Arkansas in an attempt to validate the models used by the AGFC as well as to provide baseline data on the animals at the periphery of their range. Specifically, population abundances will be calculated using a combination of night surveys and mark-recapture techniques, morphometric correlations conducted, and reproductive traits will be analyzed by laparoscopic examination of the gonads and clutch excavation. Nests will located by implanting radio transmitters into mature females and tracking them to their nests. Additionally, size-class dispersion and macrohabit preference will be discerned using GIS software. The GIS analyses will determine if populations

are separating based on size or sex and if they are preferentially avoiding areas of high human contact potential (i.e. boat routes and ramps).

Systematics and Population Structure of the Chicken Turtle, *Deirochelys reticularia*

Nathanael Hilzinger
Faculty Mentor: David Starkey

The chicken turtle (*Deirochelys reticularia*) is a semi-aquatic species inhabiting ponds and lakes throughout much of the southeastern United States. Currently, the species is classified into three subspecies based on morphological characteristics. However, environmental conditions can greatly affect morphology and in light of recent molecular data which indicates a classification inconsistent with the morphological data, the accuracy of the current subspecies classification is questionable. In order to better determine the relationship among chicken turtle populations, a systematic study will be conducted by sequencing and comparing mitochondrial genes from chicken turtle populations throughout the species' range. In addition, there has been growing interest into the effects of habitat fragmentation on gene flow among animal populations. Most studies have been concerned with species that have been impacted by anthropogenic disturbances. The chicken turtle represents a species that naturally occurs in fragmented population, and is ideal for expanding our knowledge into how fragmented populations are structured. Therefore, the genetic structuring of five chicken turtle populations within Arkansas will be compared by using microsatellite variation in order to compare levels of population diversity.

Reproductive Ecology of the Alligator Gar, *Atractosteus spatula*, in the Fourche LaFave River, Arkansas

Tommy E. Inebnit
Faculty Mentor: Reid Adams
Collaborator: Lindsey Lewis, USFWS

The alligator gar, *Atractosteus spatula*, has declined throughout its range in the southern United States. Very little information is available on the reproductive biology of this large, riverine species in need of conservation. We documented spatial and temporal aspects of the alligator gar's reproductive ecology following the discovery of young-of-year individuals in the Fourche LaFave River system, a tributary of the Arkansas River. During spring and early summer of 2007, we determined the timing and location of alligator gar spawning events by sampling larvae with dip nets and seines, as well as, a direct spawning observation. Initially, we found evidence of two spawning events (late May and mid to late June) in two small, lowland tributaries of the Fourche LaFave River (West Fork Mill Creek and Lawson Creek). The spatial pattern of abundance of alligator gar larvae suggested spawning occurred primarily in tributaries as no larvae were collected in adjacent floodplain or main channel habitats. On the afternoon of June

17, we directly observed spawning in West Fork Mill Creek and subsequently monitored egg masses and early larval stages. Spawning events corresponded with an increase in river stage on the lower Fourche system due to back flooding from the Arkansas River when water temperatures ranged from approximately 22°C to 25°C. Flood waters receded during late July, and juvenile alligator gar (19.5 – 43 cm TL) isolated from the mainstem of the Fourche LaFave River were found in West Fork Mill Creek, Lawson Creek, and an additional tributary, Caney Creek. Currently, 92 alligator gar juveniles are involved in a mark-recapture study to examine condition, growth, and survival in disconnected tributaries. Our initial observations underscore the value of small, 1st-order tributaries as spawning and nursery habitat for alligator gar and highlight the importance of considering entire drainage networks in the conservation of large-river fishes.

Fishy Explorations on the Fourche LaFave River: Who were the Beneficiaries of an Extensive Summer Flood?

Tommy Inebnit, Joseph Hartman, Luke Driver, and Richard Walker
Faculty Mentor: Reid Adams

The flood-pulse concept predicts that fish production and the reproductive success of fishes in floodplain river ecosystems will be maximized during flooding. The response of fishes will vary with the timing, duration, and magnitude of a flood event, but knowledge of how fish species are influenced by flood characteristics is incomplete. It is imperative to fill knowledge gaps given the world-wide degradation of river-floodplain ecosystems, particularly the reduction of floodplain area and altered hydrology. We characterized fishes, both adults and young-of-year, utilizing an inundated area of the floodplain of the Fourche LaFave River in Arkansas associated with high magnitude, high duration summer flooding during 2007. Using a novel technique, we sampled fishes continuously from 20-28 July in a tributary draining a portion of the floodplain with a modified box trap. Fishes were sampled during the descending limb of the flood event. A total of 42,882 individuals, including 39 species, were captured during sampling. A majority of fishes captured, representing 20 species, were young-of-year individuals indicating substantial use of the inundated floodplain as nursery habitat. A large percentage of young fishes were *Dorosoma petenense* followed by *Cyprinus carpio*, *Pomoxis annularis*, *Lepomis macrochirus*, and *Dorosoma cepedianum*. The summer flooding event, initiated by high discharge in the Arkansas River, appeared to have enhanced the reproductive success of fishes in the Fourche LaFave River system, particular species that spawn during late spring and early summer. The data documented species-specific responses to the flood event and highlighted the value of connectivity, both laterally and from a drainage network perspective, in river-floodplain ecosystems.

The Role of Sodium Hydrogen Exchangers in MCF-7 Tumor Cell Survivability

Willis Johnson
Faculty Mentor: Steven Runge

Tumors are often marked by insufficient blood flow due to their rapid growth, creating regions of hypoxic (low oxygen) and acidic (low pH) tissue. These conditions can induce apoptosis (programmed cell death), yet some cancerous cells are able to survive. This project is designed to delineate a survival mechanism for these cells in this detrimental environment. Long term, identification of these mechanisms will offer targets for the induction of apoptosis in tumor cells. The sodium hydrogen exchanger (NHE) family of proteins plays a significant role in the pH regulation of cells. It has been demonstrated that some isoforms are trafficked under stress and that mRNA expression of some isoforms is changed under stress. The goal of this research is to test the hypothesis that exposure of MCF-7 human breast cancer cells to different levels of pH and oxygen stress will result in both increased expression of NHE proteins on a whole cell basis and also an increased proportion of the NHE proteins will be trafficked to the cell surface. We will compare the NHE family member protein abundance in the membrane and whole cell of MCF-7 cells by subjecting cells to both stresses (hypoxia *and* acidification), solely to hypoxia, or solely to decreasing extracellular pH. These variables will be separated in an attempt to isolate the environmental factor responsible for any observed changes in NHE expression or subcellular location. Harvesting will take place 1 hour after conditioning to measure acute responses and 2 days after conditioning to measure adaptive responses, and samples will be taken of whole cell or plasma membrane expression to determine if responses are cell trafficking, protein synthesis, or both. By examining the role of NHEs in tumor cell survivability, a new understanding of cancer may be reached that could lead to novel approaches to treatment with better prognoses and fewer relapses.

Estrogen Metabolites Have Similar Effects on Endothelin-1 Constriction

Renee Jordan and Bonnie Schlicker
Faculty Mentor: Brent Hill

The main metabolites of estrogen (17β-estradiol, E2) are 2-hydroxyestradiol (2HOE) and 2-methoxyestradiol (2MeOH). Endothelin-1 is a potent vasoconstrictive peptide whose synthesis is increased with vascular disease. The purpose of the study is to compare 17β-estradiol and its metabolites on their abilities to decrease the endothelin-1-induced constriction of coronary arteries. Right coronary arteries were obtained from female pig hearts, sectioned into 3 mm rings, and suspended into organ baths. The artery segments were normalized by generating a length-tension relationship using a 60mM potassium solution. 2HOE, 2MeOH, and E2 were added to the organ baths for one hour before generating a contraction to 1x10-7 M endothelin-1. The overall net constriction and relaxation of the artery rings was recorded using the Dataq acquisition system. The data suggests that 2HOE, 2MeOH, and E2 slightly decreased (though not

significantly) the endothelin-1 constriction by a similar magnitude. The lack of significance is most likely due to the fact that ET-1-induces a contraction using two different sources of calcium; its release from the sarcoplasmic reticulum and extracellular calcium influx. Overall, this study suggests that E2, 2HOE, and 2MeOH do not have a dramatic effect on the potent constrictive peptide, ET-1.

Developing a Staging Model for *Rubus* Prickles

Allicia Kellogg, Coleman Little, Jordan Haas, and Ben McMurry
Faculty Mentor: J.D. Swanson

Most organisms rely on dermal tissue for protection from pathogens entering the body. Many plant species have the ability to produce an added defense mechanism in the form of spines, thorns, prickles, or trichomes. Surprisingly, there is very little known about a prickle's developmental and molecular mechanisms. To initiate studies on prickle development, we have selected as our model system the genus *Rubus*, which include the brambles. *Rubus* species are a very good choice for prickle development research since both prickle and prickleless varieties exist. Generally, growth in plants originates from special groups of cells called meristems. Meristem cells maintain an embryonic state and continually divide throughout the life of the plant. Currently it is unknown if prickles develop from a meristematic origin. Additionally, based from previous work in our lab we have found evidence to suggest that prickles may be modified trichomes. In an effort to create a staging series to encompass prickle development and provide the basis of further studies we are integrating: (A) light microscopy, time-lapse photography and SEM imaging of developing prickles, (B) identifying the roles of key meristem and/or trichome genes involved in early prickle development, and (C) identifying lignification (the final hardening stage) in prickles to create a staging model for *Rubus* prickles.

Utilizing Molecular Markers to Establish the Genetic Relatedness Within Selected Families and Genotypes of Blackberry Plants

Nicole Knox and Madeline Richmond
Faculty Mentor: J.D. Swanson

When a population is developed for agriculture, its homozygosity may increase due to selective breeding, rendering it incapable of coping with disease or shifts in climate. Outbreeding increases a population's genetic diversity by introducing genetic material from unrelated individuals. This improves the overall "genetic health" of the population by reducing homozygosity due to inbreeding and increasing the number of heterozygous individuals. Blackberries have an important agricultural role in the United States. Several varieties of blackberry exist because it is bred to display different traits, such as larger fruit or fewer prickles. We are initiating DNA marker studies to look at the diversity of breeding individuals developed by Dr. John Clark at the University of Arkansas. We have extracted genomic DNA from eleven parent plants and twenty individuals within two breeding families of blackberry using a protocol

we developed for this study. The Polymerase Chain Reaction is being used to amplify specific fragments of DNA using SSR and iSSR molecular markers based on the published literature. We expect to find that individual plants from a family share more genetic similarities compared to unrelated breeding plants. Data obtained through this study will contribute to the current knowledge regarding the genes and molecular pathways that specify preferred traits in blackberry and other plants within the genus *Rubus*.

Physiological levels of 2-methoxyestradiol stimulates calcium-activated potassium channels

Paige McGilvray and Adam Cox
Faculty Mentor: Brent Hill

2-Methoxyestradiol (2-MeOH) is a major breakdown product of the major female sex hormone, estrogen. The purpose of this study is to determine if 2-MeOH can increase the expression and activate calcium-activated potassium (K_{Ca}) channels. The selective activation of these channels will typically limit the ability of a blood vessel to constrict, and thus, enhance blood flow to the heart. Coronary arteries were dissected out of hearts from female pigs, sectioned into rings and suspended in organ baths. Rings were exposed to a 30 mM potassium solution (30K) and then were incubated with various concentrations of 2-MeOH for 60 minutes (10^{-9} M to 10^{-4} M) in the presence or absence of 1 mM tetraethylammonium (TEA, potassium channel blocker); a final contraction to 30K was then generated. There was a 20% increase in the contractile force generated in response to the lower [2-MeOH]. Also, arteries were incubated for 24 hours in 2-MeOH (10^{-12} M and 10^{-9} M) and then homogenized for Western blot analysis on the whole cell lysate. The immunoreactivity against the α subunit of the K_{Ca} suggests an increase in protein expression after the 10^{-9} M 2-MeOH exposure. Overall, our study suggests that circulating plasma 2-MeOH in females may help enhance blood flow to the heart by activating K_{Ca} channels.

Modulation of the unfolded protein response by MCF-7 cells during adaptation to a tumor-like microenvironment

Josiah Moody and Jennifer Rainey
Faculty Mentor: Steven Runge

Eukaryotic initiation factor 2α (eIF2α) is a critical factor in modulating the unfolded protein response (UPR) in response to cellular stresses, such as those found within poorly vascularized tumors. In particular, phosphorylated eif2α inhibits general protein synthesis activities while selectively activating the expression of UPR-related pro-survival and, if phosphorylation is prolonged, pro-apoptotic genes. We investigated the effects of simulated *in vivo* tumor-like microenvironmental stresses of hypoxia and extracellular acidification on the UPR in human breast cancer (MCF-7) cells. We found that cells adapted to growth at low extracellular pH (6.25 pH_e) show no phosphorylation of eif2α, while low pH-adapted cells subsequently subjected to 6

h, 24 h, and 10 d hypoxia incubation display phosphorylation of eif2α similar to that of thapsigargin treatment, a positive control agent for UPR induction. These results suggest a dynamic relationship between cellular stress and eif2α status: cells appear to phosphorylate eif2α as a means of survival in response to acute stress and additive stresses, yet are able to overcome and adapt to a chronic single stress.

Identifications of Prickle Development Genes in *Rubus* Using a Subtractive cDNA Library

Nathan Jones and Felicia Plunkett
Faculty Mentor: J.D. Swanson

Prickles are epidermal growths in plants that serve as a physical first line of defense against herbivores. Prickles can be found in many plants, including blackberry and raspberry, members of the genus *Rubus*. Prickles are important not only to the plant, but also to growers and breeders, as the presence prickles is an undesirable trait in cultivated plants. Knowledge of the genes involved in prickle development could be used to aid in production of prickleless crops. Additionally, the study of prickle development may lead to important insights into cell-to-cell communication and the control of cell proliferation. For example, we hypothesize that some prickleless *Rubus* phenotypes may be due to a "stop proliferation" signal caused by a mutation compared to the prickled phenotype, whereas other prickleless phenotypes may be due to the lack of a signal that initiates prickle development. To identify genes important in prickle development, we created subtractive cDNA libraries from prickled and prickleless varieties of raspberry. Subtractive libraries are expected to be enriched for differentially expressed cDNAs, in this case, genes that are expressed differently between the prickled and prickleless varieties, thus likely representing prickle-related genes. Additionally, publicly available DNA sequences from the leaves and stems of the closely related species, strawberry, are being analyzed. As many of the strawberry sequences are from the epidermis, they may provide additional candidates for epidermal signals involved in prickle development. Initial results show a variety of genes including transcription factors and genes involved in cell cycle regulation. In the future, potential prickle-development genes will be subjected to functional analysis using *in-situ* hybridization, real-time PCR, gene knockout, and transformation into prickleless blackberry and the model organism *Arabidopsis thaliana*.

Temporal Patterns Of Development In Southern Brook Lamprey (*Ichthyomyzon Gagei*) In Cadron Creek, Arkansas.

Sarah Pavan
Faculty Mentors: Ginny Adams and Reid Adams

Lampreys are one of the few living representatives of the ancient jawless fishes. Of the four species in Arkansas, three are nonparasitic, including Southern Brook Lamprey, *Ichthyomyzon gagei*. *Ichthyomyzon gagei* live for approximately 51 months and have a distinct larval and adult

period. Subsequent to spawning, adults die due to loss of the digestive tract that occurs during adult transformation. Specimens were collected from September 2004 through April 2006 with a backpack electrofisher. We measured total body length, eye diameter and weight of the digestive tract, gonads, fat, and total body. Eye diameter increased significantly throughout the collection period in both metamorphosing and non-metamorphosing individuals. Metamorphosing individuals developed a significantly larger eye compared to non-metamorphosing individuals. Gonadal development began in November and gonadosomatic index (GSI) peaked in January and remained high through February. In metamorphosing individuals GSI was negatively correlated with both visceral fat ($r = -0.73$, $P < 0.001$) and digestive somatic index ($r = -0.72$, $P < 0.001$). Digestive tract mass of metamorphosing specimens decreased sharply during early (September to November) metamorphosis to a nonfunctional remnant and feeding ceased. As a result, energy stored as fat is utilized for the large energy requirements of gonad development. Based on our data, use of digestive somatic index may provide a mechanism for detecting transformers at an earlier date than previous studies. Due to the imperiled status of several lamprey species, species determination at the ammocete phase is critical to understanding and protecting these species

Regulatory Effects of Protein Kinase A on SERCA Expression in Coronary Arteries

Andreya E. Reed and Edwin Muldrew
Faculty Mentor: Brent Hill

The Ca^{2+}-ATPase pump (SERCA) found in the sarcoplasmic reticulum (SR) membrane is responsible for the re-uptake of Ca^{2+} from the cytosol into the interior of the SR. Therefore, this pump is able to regulate intracellular calcium levels to control arterial tone. Our lab previously found that pre-menopausal levels of estrogen (E2, 1 nM) increases SERCA and protein kinase A (PKA) expression. Investigators have demonstrated that PKA increases SERCA activity; however, it is not known if PKA can control SERCA expression. Therefore, we hypothesized that the increase in PKA expression can regulate the expression of SERCA. The distal portions of right coronary arteries obtained from female porcine hearts were cut into longitudinal strips. The strips were incubated for 24 hours in EtOH (E2 solvent), DMSO (PKA inhibitor solvent), E2 (1 nM), and E2 + PKA inhibitor. Antibodies reactive to SERCA2b and β-actin were used to determine their immunoreactivity in the homogenized tissue. Our data indicates that E2 independenly increases SERCA2 and PKA expression; however, PKA does not have any effect on SERCA expression. This suggests that regulatory kinases other than PKA must be responsible for the higher SERCA expression, which may provide a cardioprotective benefit for pre-menopausal women.

Effects of Physical Habitat Alteration on Fish Communities in the Middle Fork Saline River, AR

Sarah Scroggins, Leslie Patrick, Chad Blackburn, Lainy Burkard, and Richard Walker
Faculty Mentor: Ginny Adams

As agriculture and urban development continue to infringe upon the borders of riparian zones, ensuing environmental concerns including loss of riparian vegetation, increased erosion, and sedimentation into streams may severally alter biotic communities (Indiana Division of Fish and Wildlife 2002). The Middle Fork of the Saline River is in close proximity of Hot Springs Village and is currently being affected by human growth and development. Initial biological assessments of the Middle Fork are important in understanding the effects of physical habitat alterations on fish communities. The primary focus of our research was to determine the relationship of fish communities between two levels of physically impacted habitats. We sampled riffle habitats at five sites and later sorted the samples in the laboratory. An appraisal of instream and riparian habitat was calculated using an Index of Habitat Integrity (IHI) Score. Fish data were analyzed using the Shannon Diversity Index, percent composition, and catch per unit area. Based on the IHI score, the results from a t-test indicated that there was a significant difference ($P = 0.0001$) between the high (52.2200 ± 4.4155) and low (96.3428 ± 5.2775) impacted sites. We collected six sensitive fish species, from a total capture of 23 taxa. *Noturus lachneri,* a sensitive endemic species, showed a significant difference ($P = 0.02$) in mean abundance between the high (2.4615 ± 1.1964) and low (7.4285 ± 1.6304) impacted sites. This research is an on going project in cooperation with The Nature Conservancy for current steam bank restoration.

Determination of FtsZ's Role in Mitochondrial Fission

Brittany Sexson and Amanda Jones
Faculty Mentor: Kari Naylor

Mitochondria are organelles that provide cells with energy in the form of ATP. Normal mitochondrial function is dependent upon the proper maintenance of mitochondrial structure. For example, mitochondria must maintain a highly branched network of tubules in the model system *Saccharomyces cerevisiae,* which occurs via balanced mitochondrial fission and fusion events. Disruption of mitochondrial function in humans may ultimately result in disease, such as Charcot-Marie Tooth or Dominant Optic Atrophy. A dynamin-related protein is thought to be responsible for mitochondrial fission events in higher eukaryotes, while an FtsZ mechanism is thought to regulate mitochondrial division in primitive eukaryotes. Two FtsZ proteins - FszA and FszB - were recently discovered in the model organism *Dictyosteilum discoideum.* Analysis of knockout strains in this system revealed morphological changes in mitochondrial structure, suggesting that these proteins function in mitochondrial fission events. The specific aim of this project is to determine the role of FszA in mitochondrial fission in *D. discoideum*. To accomplish this goal, we have determined our strain's generation time and identified its growth

phases, and have begun preliminary confocal analysis with the ultimate goal of identifying and quantifying fission and fusion events. This project will not only aid us in determining whether FszA plays a regulatory or mechanical role in the mitochondrial fission process, but also increase our overall understanding of mitochondrial fission across all eukaryotic lineages.

Estrogen increases SERCA expression and activity in coronary arteries

Lauren Sideroff and Edwin Muldrew
Faculty Mentor: Brent Hill

The sarcoplasmic reticulum (SR) is responsible for sequestering intracellular calcium to prevent intracellular Ca^{2+} overload or to mediate vascular relaxation. For instance, a fraction of the Ca^{2+} entering the cell due to membrane depolarization is sequestered by the SR calcium-ATPase pump (SERCA). The aim of this study was to determine if we could correlate the estrogen (E2) induced changes in SERCA expression with vascular tone. Right coronary arteries were dissected from female pig hearts. The distal portion of the arteries was sectioned into longitudinal strips and incubated for 24 hours in physiological concentrations of E2 (1×10^{-9} M and 1×10^{-12} M). After 24 hours the tissue was homogenized to determine immunoreactivity against SERCA2. Our results indicate that E2 elicits a 52% higher increase in SERCA expression than that of the negative control. To measure vascular tone, coronary arteries were sectioned into rings and suspended in organ baths. The SR was depleted of Ca^{2+} using caffeine, and the contractile response to a low Na and KCl depolarizing solution in the absence and presence of thapsigargin (SERCA inhibitor) was measured. Our preliminary results show that the E2-induced increase in SERCA expression generates a contraction at a slower rate. Therefore, E2's upregulation of SERCA expression in the SR may contribute to the cardiprotective benefit of E2 in women.

Characterization of the Persisting Subplate Cell Population from Early Life Through Advanced Ages

Terri Teague-Ross, Susan Lantz, Courtney Davis, Danielle Atwood, Amanda James, Adam Kilgore, and Lalita Oonthonpan
Faculty Mentor: Barbara Clancy

The cortex, also known as "gray matter," is the outermost portion of part of the brain and contains cells involved in cognitive function. Just below the cortex lies the "white matter", consisting of cell connections covered in a fatty substance known as myelin. These connections link other regions of the brain to the cortex itself. The cells we study, persisting subplate cells, are located in rats just where these two regions meet. These previously overlooked cells were once thought to disappear after the early stages of development, yet a portion of them survives, maintaining long range connections with the cortex throughout adulthood. Although there is much to be learned about these seldom-studied cells, we hypothesize that they have importance,

since in humans, they are disrupted in schizophrenia and other cognitive disorders. Because structure and function are known to be related in all biological systems, mapping the normal three-dimensional (3-D) structure and distribution of the persisting subplate population is the initial step in discovering the role these mysterious cells play in normal and abnormal brain function. The persisting subplate cells have never before been investigated past the age of 60 days (young adulthood) in rats, the standard neuroscience model. We are establishing the precise location and structure of these cells across development and aging by use of microinjection, immunohistochemistry, light and fluorescence microscopy, computer modeling, and stereology, a method of estimating cell population. Our lab is the first to construct 3-D computer models of persisting subplate cells in rats, mapping them from shortly after birth through 1 year of age, the equivalent of a human in late middle age.

An assessment of Arkansas' antimicrobial flora: methodological considerations for medicinal ethnobotany.

Mandy Waggoner
Faculty Mentors: John Choinski, Uma Garimella, and Rick Noyes
Collaborator: Justin Nolan

This poster examines plants identified as having germicidal properties by expert herbalists of the Arkansas Ozarks. Modern methods of chemical extraction and bioassay reveal correlations between ethnomedical beliefs about plants and their levels of antimicrobial activity. Nolan (2001) identified a list of 45 species as having potential germicidal properties. An extensive literature search indicated that over sixty-six percent of these plants tested positively for anti-microbial activity. The remaining species will be collected, extracted and analyzed for anti-microbial activity, although the scarcity of certain species will necessitate a micro-extraction and bioassay protocol. Here these protocols are discussed as potentially effective and ecologically responsible analytic approaches to medical ethnobotany when very small amounts of dried botanical materials are available.

Food Habits Of Sympatric Spotted (*Lepisosteus oculatus*) And Shortnose (*Lepisosteus platostomus*) Gar During Flooding Of An Arkansas River Tributary

Richard Walker, Justin Benton, and Tommy Inebnit
Faculty Mentor: Reid Adams

Gars are generally thought to be avid predators, predominantly feeding on fishes, and to a lesser extent, invertebrates. Though southern river systems typically contain multiple gar species, few studies have examined feeding characteristics of sympatric populations. Further, little information exists on food resources of shortnose gar *Lepisosteus platostomus*. We report results of an examination of diet in shortnose gar and spotted gar *Lepisosteus oculatus* from the Fourche LaFave River in Arkansas. Stomachs were dissected and examined from 74 adult spotted gar (46

- 81 cm TL) and 91 adult shortnose gar (49 - 76 cm TL) collected during May to July 2007, corresponding to back-flooding from the Arkansas River. Forty-seven (64%) spotted gar and 54 (59%) shortnose gar contained identifiable prey items. Considering frequency of occurrence, important food resources of spotted gar were fish (74%), crayfish (26%), aquatic insects (11%), and terrestrial insects (9%). Similarly, fish (59%) was the most commonly occurring food item in shortnose gar, but they consumed aquatic (24%) and terrestrial (35%) insects more frequently than spotted gar. Additionally, shortnose gar utilized amphibians (17%) as prey. Our analyses suggest similar-sized, sympatric spotted gar and shortnose gar had different feeding habits where shortnose gar utilized a wider variety of prey, including both aquatic and terrestrial food resources.

Caf4's Role In Mitochondrial Fission Events

Emily Woods and Justin Allen
Faculty Mentor: Kari Naylor

Mitochondria are double-membrane organelles responsible for production of ATP- a cell's energy source. Mitochondrial function is dependent upon a specialized structure; mitochondria are tubular and highly branched, quite unlike the jellybean structure shown in textbooks. Two classes of membrane events known as fusion and fission maintain this specialized structure. If these events are not balanced, the structure will be compromised, possibly leading to mitochondrial diseases, such as blindness or muscular weakness. In *Saccharomyces cerevisiae*, our model system, there are three proteins required for mitochondrial fission: Dnm1, Fis1, and Mdv1. A newly identified protein, Caf4, a homolog to Mdv1, has also been suggested to play a role in fission; however, little is known about its function. The purpose of these experiments is to determine the role of Caf4 in mitochondrial fission by determining the differences between Caf4 and Mdv1. Crude domain swapping between three domains of Caf4 and their corresponding domains of Mdv1 will be achieved using a yeast gap repair cloning method. Presented here is the technique of gap cloning in yeast. Results from this work will give us insight into the mechanism of mitochondrial fission and further understanding of the relationship between mitochondrial dynamics, structure, function and disease.

CHEMISTRY

Use Of Sulfur Tetrafluoride to Produce Perfluorinated Monomers

Stefanie Gardner and Tyler Staten
Faculty Mentor: Kyle Felling

A perfluorinated ketone, $C_6F_5CO(CF_2)_6CF_3$, has been synthesized by the Grignard alkylation of pentafluorophenylmagnesium bromide with perfluorooctanoyl chloride. Subsequent fluorination with sulfur tetrafluoride produces the perfluorinated alkylbenzene, $C_6F_5CF_2(CF_2)_6CF_3$, in near quantitative yield. Complete characterization by FTIR, GC/MS, and NMR is presented. This compound will be used to produce fluorinated monomers suitable for Diels-Alder polymerizations. Synthesized polymers will resemble fluorinated versions of Dow's commercially available hydrocarbon "SiLK" materials.

A Photochemically-Triggered Amino Acid Radical Precursor

Tori M. Green and Trinh Thi Ba
Faculty Mentor: Nolan Carter

Radical intermediates have long been implicated in the damage of biomolecules such as proteins. Radical damage pathways often involve a cascade of reactions that can be initiated by reactive oxygen species such as hydroxyl radical. This intermediate generates protein-centered radicals capable of undergoing subsequent reactions. The study of this process is complicated by the fact that hydroxyl radical is nonselective and can attack a particular amino acid at multiple sites, leading to multiple protein centered radicals. In an effort to circumvent this problem, an amino acid containing a photolabile phenylselenyl group has been designed. Photolysis of this amino acid will induce C-Se bond homolysis, thereby specifically generating an amino acid radical. Hence, this compound will provide a model system with which to study the mechanism of radical mediated protein damage.

The Influence of Type-II Diabetic Drugs on Retinoid Metabolism

Jordan Brazeal
Faculty Mentor: Melissa Kelley

Retinoids, vitamin A analogs, have important implications in Type-II diabetes. All-*trans*-retinoic acid (*t*-RA) and 9-*cis*-retinoic acid (9-*cis*-RA) act as ligands for retinoic acid receptors (RAR) and retinoid X receptor (RXR). These receptors form heterodimeric partners with other receptors including peroxisome proliferators-activated receptor gamma (PPARγ). When RXR and PPARγ dimerize, they initiate the transcription of proteins that decrease blood sugar levels.

One such family of diabetic drugs, thiazolidinediones (TZDs), have two biochemical functions. First, TZDs act as ligand for PPARγ. Secondly, they are inhibitors of cytochrome P_{450}, which is responsible for the metabolism of *t*-RA. This project investigates the metabolism of *t*-RA in the presence of TZDs. Using Sprague-Dawley male rat microsomes, which contain the cytochrome P_{450} family of enzymes, metabolism of *t*-RA was examined in the presence and absence of TZDs. The goal of our research is to determine if metabolites of *t*-RA are altered in presence of TZDs.

Isolation and Characterization of All-*trans*-Retinoic Acid Isomers

Seth Gardner
Faculty Mentor: Melissa Kelley

All-*trans*-retinoic acid and its isomer 9-*cis*-retinoic acid (9-*cis*-RA) are biologically active metabolites of vitamin A (retinol) and play an important role in many critical life processes including vision, reproduction, cellular development, and epithelial cell differentiation by mediating gene expression. In this project, *t*-RA was dissolved in ethanol, methanol, or hexanes and exposed to visible, short-range, or long-range ultraviolet light. Samples were collected at 5 minutes intervals for 20 minutes after exposure to UV radiation. Reverse-phase high performance liquid chromatography (HPLC) with photodiode array detection was used to isolate retinoid isomers present in the samples. Isomers were formed when *t*-RA was exposed to UV light in methanol, ethanol, and hexane. Retinoid isomerization appears to occur faster in small polar solvents, with non-polar bulkier solvents having a slower rate. Our data suggests that solvent polarity and size plays a significant role in all-*trans*-retinoic acid isomer production.

Retinoid Metabolism in Human B Lymphocyte (RPMI 8866) Cell Line

Rachel Grandon
Faculty Mentors: Lance Bridges and Melissa Kelley

Vitamin A and its analogs, retinoids, are essential for many critical life processes including vision, reproduction, cellular development, and immune function. All-*trans*-retinoic acid (*t*-RA) is a biological active retinoid, which is involved in regulating immune function. How retinoids function in immunity is unclear. Currently, all-*trans*-retinoic acid has been demonstrated to augment cell adhesion in a human B lymphocyte cell line RPMI 8866. However, retinoid metabolism has not been examined in this cell line. Oxidative metabolism of *t*-RA will produce products that are less biologically active, and potentially less effective in regulating immune function. The goal of our study is to extract retinoids from cells treated with *t*-RA. Using HPLC with photodiodearray detection, retinoid metabolism was assessed. Our study is the first to demonstrate that t-RA is not metabolized, and the augmented cell adhesion is clearly due to *t*-RA and not its metabolites.

Human ADAM7 mRNA is Expressed in B-Cell Lineages

Joshuah D. Lingo
Faculty Mentor: Lance Bridges and Melissa Kelley

ADAMs (a disintegrin and metalloprotease) are a novel protein family exhibiting both adhesive and proteolytic properties. Aberrant ADAM function has been implicated in various diseases such as tumor onset/progression, rheumatoid arthritis, and Alzheimer's. This study profiled the expression pattern of human ADAM7, a proteolycally inactive ADAM, in four distinct human blood cell lines. Although human ADAM7 message has been previously localized to the epididymus, we posit that ADAM7 is also expressed by lymphocytes since: 1) ADAM7 exhibits extensive homology with ADAM28, a mature B-cell ADAM, 2) ADAM7 is recognized by lymphocyte receptors, and 3) ADAM7 is found in succession on the same chromosome with two other ADAMs expressed in immune cells. Through reverse transcriptase PCR analysis, our results are the first to demonstrate that ADAM7 mRNA is present within human B-cells providing support for our model that inactive ADAMs serve as competitive regulators of active ADAMs.

Plasma oxidation and accelerator mass spectrometry of charcoal and inorganic Australian rock paintings

Josh Loewen and Jeremy Mackey
Faculty Mentor: Karen Steelman
Collaborators: Josephine McDonald, Peter Veth, and Thomas Guilderson

Rock paintings from the Australian Western Desert were radiocarbon dated using plasma oxidation and accelerator mass spectrometry. Nine charcoal and twelve inorganic-pigmented samples were treated with sodium hydroxide to remove potential humic acids. Plasma oxidation converted organic material in the paint samples to carbon dioxide and water. Samples of unpainted rock contained insignificant amounts of organic contamination, allowing successful analyses. Bayesian statistical calibration, SHCal04, of ages ranging from 10±35 years BP (modern) to 3190±60 years BP demonstrated a precise calendar age range for samples from the same location consistent with known pre-historic occupation patterns. To our knowledge, this is the first instance that both charcoal and inorganic-pigmented paint samples have been dated from the same image. Results support the accuracy of using plasma oxidation to accurately radiocarbon date inorganic-pigmented paintings.

Radiocarbon measurements of carbonaceous aerosols from Mexico City in 2003

Amanda MacMillan
Faculty Mentor: Karen Steelman
Collaborators: Nancy Marley, Jeffrey Gaffney, and Thomas Guilderson

Carbonaceous aerosol samples, collected at an urban site in Mexico City during April 2003, were analyzed for radiocarbon content to determine their biomass-to-fossil fuel ratios. Using high-volume samplers, collection of less than one-micron particulates on glass-fiber filters occurred for continuous twelve-hour intervals. Our laboratory converted organic material in the aerosol samples to carbon dioxide and water using a custom-built plasma oxidation apparatus, followed by accelerator mass spectrometry radiocarbon measurement. For twenty-three samples, values ranged from 0.56 to 0.86 indicating a substantial contribution from modern carbon. A fire in the Yucatan impacted the city during the last seven days of the month with AM and PM fraction modern averages of 0.70 and 0.77. A slight increase in the 14C content during the fire event is consistent with biomass burning impact. Data clearly indicate that biomass sourced carbonaceous aerosols are a major contributor to the aerosol in this important megacity.

GC/MS Analysis of Ancient Cave Paintings

Michelle McClain
Faculty Mentor: Karen Steelman

Our research laboratory is investigating the identity of organic components in ancient cave paintings. The high carbon content of paintings from the Lower Pecos River Region of southwest Texas makes them an ideal candidate for organic analysis. We performed fatty acid methyl ester derivatization prior to gas chromatography/mass spectrometry analysis to determine if suspected fatty acids from either plant or animal components were added to make the paint. Studies on control samples indicate that the multiple steps of our current procedure introduce contamination. We are now trying a simpler procedure using BSTFA for silylation of the fatty acids. Once procedural protocols are established, we will perform the analysis on samples of painted and unpainted rock. Until the characterization of organic substances added during paint manufacture is successfully accomplished, all radiocarbon dates on rock paintings remain questionable. In addition, understanding how past cultures created their art can aid archaeologists by highlighting ancient technologies and use of the environment.

A Pilot *In Vivo* Study Of Immune Responses To A Novel Nickel-Based Anti-Tumor Compound In Mercury Susceptible A.Sw Mice

J. Leigh Methvin and D. Brett Rabeneck
Faculty Mentors: Patrick Desrochers and Ben Rowley

In vitro studies have previously exhibited cytotoxic activity of a novel nickel compound, $[dppeNi^{II}CYSEt^{+}]Cl^{-}$, in a human breast cancer cell line (MCF-7). A concern of utilizing metal molecule-based therapies in human beings, however, is allergic reactions and/or induction of immune system abnormalities. This is evident in case studies of chrysotherapy using gold-based molecules for treatment of rheumatoid arthritis. In an attempt to assess possible immune system modulation by this compound *in vivo*, a pilot project was initiated. The goal of this pilot study was to assay for immune system alteration in mercury-susceptible A.SW congenic mice following treatment with the nickel-based compound. Four groups of mice (one male, one female per group) were injected thrice weekly with 0.1 mL of 500, 50, 5, or 0 (control) μM $[dppeNi^{II}CYSEt^{+}]Cl^{-}$. All mice were tail-bled for serum weekly. Sera collected were used in enzyme-linked immunosorbent assay (ELISA) for quantification of blood levels of both IgM and IgG over the time of the study. Collected sera were secondarily subjected to immunofluorescence testing for specificity to nuclear structures in the human epithelial-2 (HEp-2) line. The combination of these two assays allows for detection not only of random and inappropriate stimulation of the immune system under chemical treatment, but also of induction of specific autoimmune response.

Reactions of $Cu^{+}(^{1}S, ^{3}D)$ with CF_3X (X=Cl, Br, I)

Scott R. Musial and Seth D. Byers
Faculty Mentors: William Taylor and Micah Abrams

State-specific reactions of $Cu^{+}(^{1}S)$ and $Cu^{+}(^{3}D)$ with CF_3X (X = Cl, Br, I) have been carried out in a selected-ion drift cell apparatus. $Cu^{+}(^{1}S)$ participates in association exclusively with all three of these neutral, whereas $Cu^{+}(^{3}D)$ abstracts X to yield CuX^{+}, which subsequently abstracts X^{-} in a secondary step. All bimolecular processes are consistent with known thermochemical and quantum mechanical requirements. Kinetic studies reveal that CF_3Cl reacts with $Cu^{+}(^{3}D)$ at approximately 7% of the ADO rate, indicating a kinetic barrier to reaction. By comparison, CF_3Br and CF_3I react at essentially the ADO limit with this Cu^{+} state – suggesting the possibility that significant mechanistic differences may exist between CF_3Cl and the other neutrals despite analogous product formation. Quantum chemical calculations have been employed to determine the stationary points along the reaction coordinate of $Cu^{+}(^{3}D)$ with CF_3X in an effort to explain differences in the observed rates of reaction and shed light on possible reaction mechanisms.

Understanding The Stability of Metal-borohydride Compounds

Chris Sutton
Faculty Mentors: Patrick Desrochers and Micah Abrams

Experimental and computational techniques were used to elucidate the structure, bonding, and the nature of the stability of two transition-metal borohydride compounds, Tp*$NiBH_4$ and Tp*$ZnBH_4$ (Tp*= hydrotris(3,5-dimethylpyrazolyl)borate). A combination of density functional theory and multi-reference configuration interaction was successfully used to reproduce the crystal structure, as well as the vibrational, electronic, and magnetic spectroscopy of these compounds. Our results show that both the η^3-Ni(II) compound and the η^2-Zn(II) compound exhibit a significant covalent interaction between the metal-center and the borohydride anion. The consistent model determined from the combination of the experiment and theory also provides insight into the stability of not yet synthesized metal borohydride compounds.

COMPUTER SCIENCE

Simulation Study on Grid Computing Performance

Guanchen Chen
Faculty Mentor: Qiang Duan

With the quick development of web technique, the need of communication and information sharing grows significantly. To meet such demand, many researchers bring in the idea of Grid computing, which works as a service for sharing computer power and data storage capacity. Grid computing goes beyond simple communication between computers and ultimately aims to turn the global network of computers into one vast computational resource. However, the management and scheduling of resource in such a large-scale Grid system is complex, therefore, we need to use tool to analysis it before applying to real world. Simulation appears to be a feasible way. Gridsim toolkit is an effective simulation tool that allows modeling and simulation of entities in Grid computing system – users, applications, resources, and resource brokers for design and evaluation of scheduling algorithms. In this research project we use the Gridsim toolkit to simulate a Grid computing system that distributes the jobs submitted by a group of users across a set of resources for processing. We measure the average delay time for job processing in various scenarios. Particularly we analyze the impact of the amount of work load and available computational resources on the average job processing delay. Such simulations and analysis provide us an insight of Grid computing performance.

Matrix Chain Multiplication: Greedy better than Dynamic Programming?

Guanchen Chen, Samuel Green, Erwin Taylor, Tony Wang, Thomas Winters, and Yin Xin
Faculty Mentor: Vamsi Paruchuri

The matrix chain multiplication problem is a classic problem in computer science, having significant practical importance. The traditional solution to this problem is to use a dynamic algorithm, of $O(n^3)$ complexity, to find the optimal solution. In this article, we propose and study a greedy algorithm of $O(n^2)$ complexity, to solve this problem. To study the effectiveness of the greedy algorithm, we propose a new metric – Total Time to Multiply (*TTM*), which is sum of time to compute the sequence for multiplying the matrixes and the time to perform actual multiplications. Even though the proposed greedy algorithm might not always find the optimal multiplication sequence, we show that the greedy solution is as good as or can even outperform the dynamic solution in terms of the Total Time to multiply.

A Research of Global Optimized Video Rate Control Algorithms

Siqing Li and David J. Carmon
Faculty Mentor: Yu Sun

Recent success of networked multimedia applications has generated a lot of research in video compression. Rate control (RC) is crucial for video compression as it regulates the output bit rate of a video encoder in order to obtain optimum visual quality within the available budget of transmission bit rate. However, most rate control algorithms are heuristic in nature, meaning that they are suboptimal and susceptible to getting stuck on local optima. In this study, we have been conducting a trial research that applies genetic algorithms to video rate control. Our research objectives are twofold: First, to obtain global optimal results; Second, to provide the upper bound as a reference base for performance evaluation of those heuristic rate control algorithms. Experimental results demonstrate that the proposed genetic rate control algorithm works well and achieves global optimal results, which can provide the upper-bound for performance evaluation of heuristic rate control algorithms.

Automated Recognition and Recovery of Potential Drowning Victims

Steven Nelson
Faculty Mentor: Paul Young

Thousands of people drown in swimming pools every year. Many of these drownings occur simply because no one is watching. In an attempt to provide a solution, the characteristics of a drowning victim, including their actions and possible medical consequences are analyzed. These characteristics and behaviors provide a basis for what to look for when detecting a drowning person. Multiple detection approaches are studied. The methods will focus on determining the posture of the potential victim. These postures recorded over a short time can be combined into a behavior that can be matched to a person in danger. Finally various aspects of submersible robotics are presented to give a foundation towards building a craft to rescue an identified swimmer in danger.

A New Coding Complexity Estimation for H.264 Rate Control

Yimin Zhou and Yin Xin
Faculty Mentor: Yu Sun

H.264, the newest video compression standard, provides significant improvement in coding efficiency when compared with other existing standards. As a crucial component of a H.264 encoder, rate control regulates compression bit rates to meet time-varying network bandwidths while obtaining optimum quality. However, the initial quantization parameter (QP) estimation of H.264 rate control scheme is inaccurate since it doesn't take intra-frames' complexities into

consideration. In this research, with the objective to obtain accurate initial quantization parameters, we propose a new complexity measure for intra-frames based on their gradient and histogram information. Our experimental results demonstrate that, when integrated with our rate control scheme, the proposed complexity measure can be used to accurate predict initial quantization parameters, and thus, enhance the overall performance of H.264 rate controller.

MATHEMATICS

Implementation of the Space Time Finite Volume Method on a One Dimensional Wave Maker

Matt Brozak
Faculty Mentor: Clarence Burg

Water waves are often modeled as the solution of a partial differential equation, which can be solved numerically on a mesh of points by using the finite-volume method. When this mesh of points moves, the solution algorithm must be altered to handle this motion. The traditional finite-volume method when applied to moving and deforming meshes requires two additional steps, which must be implemented consistently with the finite volume approach, to account for changes in the mesh by use of the Reynolds Transport Theorem and the Geometric Conservation Law. The space-time finite volume method (ST-FV) handles moving and deforming meshes seamlessly and naturally resulting in a solution that is spatially accurate and conservative. By implementing the ST-FV method on the St. Venant Equations, which are a one-dimensional model of water flow in channels, the results are both fully conservative and second order accurate. These properties are demonstrated by implementation of the ST-FV method on a virtual wave maker.

Stability of Granular-Fluid Mixture Equations.

Derek Darron
Faculty Mentor: Long Le

Granular flow is a common concept in studying geophysical mass flow. In 2005, Pitman and Le proposed a model to describe granular-fluid mixture. We will present some preliminary result in studying the stability of the linearized equations derived from this model.

Application of Richardson Extrapolation to the Numerical Solution of Partial Differential Equations in Two Dimensions

Taylor Erwin
Faculty Mentor: Clarence Burg

When modeling complex physical systems, researchers often rely on partial differential equations, or PDE's. Unfortunately, exact solutions to these equations are often not available. In these cases, computational (numerical) methods may be employed to approximate the solution. When dealing with computational solvers, accuracy is of the utmost importance. Richardson extrapolation is an algebraic technique for increasing the accuracy of numerical approximations

by considering the error in a sequence of approximations. A method for applying Richardson extrapolation to partial differential equations in one dimension has been recently developed and applied to several one-dimensional PDEs. This method is extended to partial differential equations in two dimensions and is applied to three PDE's, the wave equation, the heat equation, and the shallow water equations. This last system of equations models water flow through open channels such as rivers and aquifers.

Simulating Sensitivity of Insulin and Glucose to GLUT4 Internalization Rate

ChingChun Hsin
Faculty Mentor: Weijiu Liu

Insulin sensitivity is associated with the translocation process of the intracellular glucose transporter (GLUT4) to sarcolemma in skeletal muscle, which plays an important role in glucose uptake. Thus it is important to study the sensitivity of insulin and glucose to the rate constant for GLUT4 internalization in skeletal muscle. To simulate the sensitivity, we develop a mathematical model at a molecular level for glucose mobilization in liver and glucose uptake in skeletal muscle. The model enables us to predict that glucose and insulin are sensitive to the rate constant and that an increase of the rate constant results in a decrease in plasma insulin, cellular insulin, and blood glucose. This implies that, for a subject with a greater rate constant for GLUT4 internalization, less insulin is required to lower glucose levels.

Reactive Mixing Optimization

Eric Sellers and Chris Willette
Faculty Mentor: Weijiu Liu

We consider the problem of mixing enhancement in enzymatic chemical reactions in moving fluids, which are modeled by a reaction-convection-diffusion equation. The problem is formulated as an optimal control problem using the flow field as a control variable. By variational principles, we prove the existence of an optimal flow and derive an optimality system that consists of nonlinear reaction-convection-diffusion equations and Laplace's equations. The uniqueness of the optimal flow is left open.

PHYSICS AND ASTRONOMY

Thickness Determination Using Rutherford Backscattering Of Alpha Particles

Russell Cline and Brian Halldorson
Faculty Mentor: Rahul Mehta

A Van de Graaff particle accelerator at the Ion Beam Modification and Analysis Lab (IBMAL), University of North Texas*, propelled an alpha-particle beam at 1.5-MeV through a metal tube until it entered the scattering chamber at which point the alpha-particles collided with a sample. In the collision a very small fraction of the particles are scattered over angles greater than 90^o. The scattering chamber contained a particle detector that measured the number of particles backscattered at a known angle θ. The mass of the atom, from which the scattering took place, is determined from kinematical scattering factor (ratio of scattered energy to the incident energy of the alpha particle), θ and mass of the alpha particle. The Rutherford cross-sectional area of the alpha-particle beam on the sample atom, σ_R, was then calculated using the atomic number of the unknown substance (Z_2) and the alpha particle Z_1, the energy of the beam E and θ. The samples used were some unknown samples and a standard gold target. Thickness of the unknown could be determined by comparison of the net number of particles detected from total counts in the peak minus the background count ($\Sigma - BG$), the incident number of alpha particles and the Rutherford cross-sectional area. The data was collected and analyzed by MAESTRO software. The unknown elements, determined using kinematical scattering factor, and their ascertained thicknesses (in atoms per cm^2) were copper (Cu) 6.55×10^{17}, chromium (Cr) 3.46×10^{17}, and germanium (Ge) 2.15×10^{17}.

*We would like to acknowledge the assistance of Dr. J. L. Duggan and Dr. Khalid Hossain while conducting the experiments.

Error Analysis Of N-Capture Element Abundance In Halo Giants

E. Marilea Jones
Faculty Mentor: Debra Burris

Using the atomic oscillator strengths published in Malcheva et al 2006 for Zirconium and Hannaford et all 1982 for Yttrium, new abundances for these elements were calculated. Each element had several lines that were used to determine the overall mean abundance. Error analysis was performed on each line by finding the standard deviation for each abundance determination. Further error analysis was accomplished by recalculating the synthesis on each line after changing the temperature to a lower bound of 4000K. The same procedure was repeated, instead changing the temperature to an upper bound 6000K. These values were selected

to represent a typical range of temperatures for red giant stars. Changing the temperatures appeared to have no effect the averages for the elements.

Design of Automated System for Pain Threshold Measurement in Pre-Diabetic Rats

Sharon R. Jones
Faculty Mentor: Azida Walker

There are approximately 800,000 new diabetic cases every year. One current diabetic research study at UAMS has focused on the early mechanisms of diabetic neuropathy and pain and the causes for the progressive debilitating side effects associated with diabetes. These side effects include but are not limited to numbness, insensitivity to pain or temperature variations. Here we present the initial part of an engineering design for a robotic system aimed at testing for tactile allodynia and pin-prick hyperalgesia – a technique based on a modification of the von Frey filament involving the measurements of displacement of a needle (the stimulus) and the force (needle pressure against the rat's skin). The design involves the use of a stepper motor and a controller circuit and a manipulator with a force-transducer and probe attached. The probe is 100 mm or 1mm tip diameter in the tests for hyperalgesia or allodynia respectively. The proposed automated system will replace the manual control of the experiment, increasing the accuracy of data, thus reducing systemic and experimental errors that may arise and ultimately will help the researcher to find better treatment options for these symptoms associated with diabetes.

PIXE And Rutherford Scattering of Alpha Particles*

Patrick Kells and Nathan Walsh
Faculty Mentor: Rahul Mehta

In this experiment alpha particle beam of 1.5MeV from a Van de Graaff accelerator at the University of North Texas (UNT) was used to determine the atomic makeup of unknown samples. In a second experiment the Alpha particle beam energy was varied to study the dependence of Rutherford scattering cross section on the energy. Particle Induced X-ray Emission (PIXE) involves x-ray emission in ion-atom collisions where one or more target electrons are excited to higher energy states and they emit characteristic X-rays in de-exciting. Rutherford Backscattering Spectroscopy (RBS) is the study of the elastic scattering of the incident particles with the target atoms. Law of conservation of energy and momentum is used to determine the composition of the material by relating the kinematical scattering factor (ratio of scattered to the initial alpha energy) to the masses of the incident ion & the target atom and the scattering angle. A Si(Li) detector measured the emitted x-rays while simultaneously a particle detector at a fixed back angle measured the scattered alpha particles. A computer program, MAESTRO, was used to collect and analyze the PIXE and the RBS data. The unknown sample was determined to be mainly silicon and oxygen. In the second experiment alpha particle beam was incident on a standard gold sample and RBS data was taken. We found the Rutherford

scattering cross section to be inversely proportional to the square of the alpha particle beam energy.

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Gamma Ray Spectroscopy: Determining Half-Lives And Absorption Coefficients *

Michael C. Kitchens
Faculty Mentor: Rahul Mehta

This project utilizes two applications of gamma ray spectroscopy. One experiment seeks to identify the characteristic gamma rays of the two gallium isotopes, ^{70}Ga and ^{72}Ga. These two isotopes are the radioactive result of neutron irradiation of the two stable isotopes, ^{69} Ga and ^{71}Ga. In addition to determining relative intensities and energies of the characteristic gammas, the respective half-lives of these radioactive nuclei are also calculated. The type of gamma ray detector used is a Sodium Iodide (NaI) scintillation detector. The spectra were analyzed using PCA software. The second experiment uses a gamma ray source to measure the absorption coefficient of lead as a function of thickness by measuring the change in the gamma ray intensity. The type of detector is a Hyper-pure Germanium detector. The radioactive source used is ^{137}Cs. The energies and intensities of the Cesium gammas are found by utilizing Maestro software. Prior to measurement the system was calibrated using multiple gamma ray sources. The calculated absorption coefficient (μ) for lead was found to be 0.102 cm^2/g.

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Studies of Hard and Soft Tissue Elemental Compositions in Mice and Rats Subjected to Simulated Microgravity

Ryan Lane, Holly Jumper, and Corey Kitchens
Faculty Mentor: Rahul Mehta

The effects of microgravity on mammalian physiology are not thoroughly known. To further investigate these effects, the elemental composition of the femur and skull bones as well as pancreatic tissue and muscular tissue from the head in mice and rats that have been subjected to NASA certified hind-limb suspension (HLS) to simulate microgravity are being compared to similar tissues from non-HLS control mice and rats. The Scanning Electron Microscope (SEM) at UCA is being used to conduct Energy dispersive Spectroscopy (EDS) to gain quantitative data on specimen composition, by analyzing spectrum using Flame software package created by XK Inc. Also, X-Ray Florescence (XRF) is being used to look for high atomic number ($Z > 25$) elements and to verify (EDS) data. Elemental analysis indicates a variation in the compositional

ratios of calcium, potassium, and carbon in the femurs and skulls of the HLS versus control specimens. These variations showed dependence on sample position in the bone relative to the hip joint and the sutures for the samples from the femur and skull samples, respectively.

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A Comparison Of The Light N-Capture Elements To Barium In Halo Stars

Jeremy Lusk
Faculty Mentor: Debra Burris

Abundances of heavy elements in extremely metal-poor halo stars reveal details about the nature of neutron-capture nucleosynthesis in the early Galaxy. Abundance ratios of [Ba/Sr], [Ba/Y], and [Ba/Zr] in a collection of EMP halo stars with metallicity -4 <[Fe/H]< -2 were examined. Large scatter in [Ba/Fe] vs. [Ba/Sr] at [Ba/Fe]< -0.5 seems to suggest that r-process nucleosynthesis behaved differently in the early Galaxy.

BalloonSat and LabPro: High Altitude Balloon Experiments for High School Students

Kim Mason
Faculty Mentor: William Slaton

BalloonSat is a NASA and Arkansas Space Grant Consortium funded program that gives secondary education students the opportunity to design and build scientific payloads to send to high altitudes aboard helium filled weather balloons. Recently a flight was conducted with Vernier's LabPro data acquisition system recording atmospheric temperature and pressure. Altitude was inferred from post-flight GPS data and indicated the balloon reached the edge of the tropopause. The transition into the tropopause was also indicated by the change in the temperature and pressure data taken form the launch. This data will be presented and used to demonstrate atmospheric pressure's exponential dependence on altitude as well as the dry adiabatic lapse rate. Comparisons to theory will also be presented. Hands-on experiments such as these utilizing data acquisition devices common in the technology enhanced classroom offer secondary education students and teachers the opportunity to do meaningful scientific explorations of the Earth.

Determining the Speed of Sound and Bulk Modulus of Various Fluids

Andrew Woodard
Faculty Mentor: William Slaton

Through experimentation using a tone burst generator, signal generator, an oscilloscope, a simple tube and some sending and receiving speakers it was possible to find the speed of sound in various fluids. Then using a beaker and triple beam balance it was possible to determine the density of these fluids. From density and the speed of sound through the fluid it was then possible to find the bulk modulus for each respective fluid. The fluids that were tested were; baby oil, soap, honey, ketchup, and a water cornstarch mix at various ratios.

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