

**University Committee for Undergraduate Research
7th Annual Undergraduate Research Poster Session**

2005

**Measurement of Lead and Copper in Snakes and Tadpoles
from the Mobile-Tensaw River Delta, Mobile Alabama**

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Thamnophis sauritus, *Rana clamitans*, and *Rana catesbeiana* were collected from the Mobile-Tensaw river delta in order to test them for bioaccumulation of Lead and Copper. *T. sauritus* was chosen because it is an abundant species that is an important part of the food chain in the delta. They are both predators and prey of vertebrates and invertebrates. Snakes are vulnerable to heavy metal contamination from the environment. Lead enters the environment through highway drainage ditches, mines and mine tailings and shooting ranges. Copper enters the environment primarily as a coal combustion by-product. The study conducted concluded with the fact that none of the study species were contaminated significantly with Lead or Copper.

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**An Examination of the Cytoskeletal Structure of the Vermigon Stage of the
Loxothylacus texanus life cycle**

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Callinectes sapidus, the greater blue crab, is abundant in the waters of the Gulf of Mexico. Studies show that the crab population oscillates annually. This is possibly due to the barnacle parasite *Loxothylacus texanus*, whose adult stage has the effect of castrating the adult males by hormonally rendering them female, thus negatively affecting the crab population.

Before infection, the parasite is covered by a chitinous layer and possesses a needle-like stylet anteriorly. This stage is known as the kentrogon. The stylet is responsible for the injection of a vermigon stage through the host crab's shell into the interior of the crab. Because the parasite at this stage is small and lies within the crab's body, very little is known about the early stages of the vermigon stage of the cycle. The vermigon develops a complex root system, which eventually projects itself throughout the interior of the host crab. The nascent vermigon, however, exists as a small worm-like body. Some structure can be observed in the vermigon via light microscopy. It has a central rod, which spirals along the long axis of the vermigon. Our lab has shown in preliminary work that actin filaments are oriented parallel to the central spine in the peripheral region of the vermigon, as well as within the central rod itself. When exposed to acidophilic stain, the vermigon appears to have many nuclei. However, it is not known whether or not the vermigon is a few multi-nucleated cells or many single-nucleated cells. We have used fluorescence microscopy and antibodies to cytoskeletal proteins to examine internal structure of the vermigon.

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Distributed Communication Between Robotic Agents

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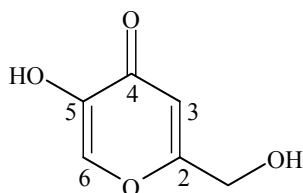
Lego® MindStorms robots are compact robots that can be used for artificial intelligence development without the extra costs associated with robot design and construction. Individually these robots are limited but, distributed robotic communication would further their usefulness. Our research considered the overhead and components involved with communication between robots and communication between a robot and a computer. In addition, we looked at the efficiency of robot to computer communication compared to that between robots. We used the Java environment associated with *leJOS* to assist in programming communication protocols. Robots were designed to accomplish basic tasks that require distributed communication between entities for faster results. Each robot knew which message to listen for via a unique address assignment. Results were promising for using communication between robots as well as the computer. The overhead for either communication scheme offers the same effectiveness overall. Efficiency per robot per message is relevant on the distance between the sender and receiver, battery life, line-of-eye relation between the sender and receiver, and message protocol implemented by the user. The robot systems are capable of having numerous mobile units that can cooperatively assist one another in solving a problem while allowing a computer to handle any processor tedious calculations using distributed communication.

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Molecular Modeling, Synthesis, and Reactivity of Kojic Acid Derivatives

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5-Hydroxy-2-(hydroxymethyl)-4-pyrone, commonly known as kojic acid, is a naturally-occurring compound found in bacterial strains, seaweed, and plant extracts. It is used extensively in food, as a dermal antioxidant, and numerous other consumer cosmetic products. Although kojic acid tightly binds transition metals such as iron, vanadium, etc., other uses in organic chemistry realm is relatively unexplored, principally due to its rather atypical chemical behavior. The unusual behavior of kojic acid (as compared to typical substituted γ -pyrones) in organic reactions and a lack of an intrinsic mechanistic understanding of its behavior prompted our further research investigations.

We have conducted extensive theoretical calculations on the parent structure as well as the structures of $-OH$ derivatized species, both at the semi-empirical (PM3) and *ab initio* levels (3BYLP/6-311G*), and guided by our theoretical findings have prepared suitably modified congeners. A derivatized form of kojic acid was subjected to a series of reactions typically associated with substituted γ -pyrones, and indeed our structural modifications allowed us to successfully prepare a series of N-substituted- γ -pyridones, hydroxy-pyryllium salts, dideoxymannopyranosides, and aza-glycomimetic precursors. All of the compounds were structurally characterized using a combination of multinuclear 1H & ^{13}C 1-D and 2-D NMR spectroscopy, GC/MS, and FT-IR spectroscopy.

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**Development of a Mathematical Model to Predict Fecal Coliform Levels in the
Mobile Bay Area**

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Bacterial contamination is a serious problem in the Alabama oyster industry. Specifically among these is the fecal coliform bacterium. This bacterium is an indicator of sewage-polluted waters. The state of Alabama currently uses a predictive model based on the stage of the Mobile River to predict these bacteria levels. This research's purpose was to develop a mathematical model based on several environmental factors. Little success was found with this problem due to poor data correlation. However, upon taking a predictive approach, a model was developed that showed a decent fit of data. Further analysis using the technique of partial least squares will be used for future investigations.

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Inducible Acid Tolerance Response of *Campylobacter jejuni*

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Campylobacters are microaerophilic and gram negative bacteria that are the leading cause of enteritis worldwide. *Campylobacter jejuni* (*C. jejuni*) infection is also the leading precipitant in the development of two neurological disorders known as Guillian-Barre' (GBS) and Miller Fisher syndromes (MFS), both of which are demyelinating neuropathies. There are an estimated 2 million cases of *C. jejuni* infection each year in US, which cost approximately \$1.5-8.0 billion annually.

Campylobacters are sensitive to heat, desiccation, acidity, irradiation, and disinfectants. *C. jejuni* is able to survive stomach acidity and cause infection despite its sensitivity to low pH. It is therefore hypothesized that surviving acidic environments is essential to pathogenesis of these organisms and that *C. jejuni* possess an inducible acid tolerance response. Our studies have shown that *C. jejuni* are killed at pH 3.5. These organisms, however, will survive pH 3.5 if they are first exposed to a mild acid stress at pH 5.5 (adaptive pH). We further hypothesized this response to be the result of alterations in cellular metabolism mediated by changes in protein expression. Two dimensional (2-D) gel electrophoresis was used to analyze cellular extracts of *C. jejuni* NCTC11168 grown under optimal (pH 7.0) vs. adaptive pH (5.5) conditions. The results show protein expression differences between *C. jejuni* grown under optimal vs. adaptive pH indicating a metabolic shift in response to exposure to adaptive pH of 5.5.

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The Real Tragedy: Western Criticism's Denial of Eastern Tragedy

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The assumption that literature and its aesthetic theories necessarily reflect an isolated system of value can occasionally be both detrimental and provincial in its conclusions. In regards to the tragic art form, conventional Western Criticism contends that tragedy is essentially a Western representation that signifies a distinct system of value in the West. Western critics not only deny the existence of Eastern tragedy based upon this rigid system of value, but also repudiate the capacity of Eastern dramatists to produce tragedies because of an assumed disparate system in the East that betrays the "tragic ideal." The implication of this peremptory attitude towards Eastern dramaturgy is disingenuous not only because of its lack of veracity and judgment, but also because of the inability of Western Critics to move beyond its myopic attitude of tragic theory that begins with Aristotle and culminates in George Steiner's "Death of Tragedy" movement. While there are certainly differences in the representations of tragedy across cultures, the repudiation of Eastern tragedy can more readily be accounted for by the tendentious evaluations of Western critics than the supposed inherent difference of system of value that separate the two cultures. What is intended here is to not only to highlight the problematic assessments and tendencies that Western tragedy have implemented, but also to broaden this theory in order to prove the existence of Eastern Tragedy.

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Unifying Germany:

**An Analysis of the Rift between Intellectuals in Opposition to
Unification and the Citizens' Desire for Unification**

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This research analyzes the rift between intellectuals in opposition to unification and the common people in East Germany during the revolution of 1989. It mainly focuses on the time period between November 9, 1989, when the Berlin Wall fell, and the 1990 March Elections of East Germany and the hopes and fears held by both intellectuals and the general public about the future of East Germany. This analysis searches for the different views of the situation and why various people came to see the situation so differently. By acknowledging various perspectives of the situation, namely the gap between intellectuals and the common people, this research hopes to give a better understanding of how and why unification took place at the time it did.

This research has found that the empowerment of the people had been the main goal of the *October Revolution*. It was the one point on which the people and the intellectuals saw eye to eye. The future of the German nation was the first major point of difference between the intellectuals and the people separating the intellectuals from the original civic movement in the fall of 1989. Decisive factors found in this research affecting the people's perception of socialism or any future for the sovereign state of the GDR as the East German intellectuals perceived it were: (1) the GDR government's initial refusal to completely comply with the demands of the people to dissolve the Stasi, (2) the government's disclosure of the economic condition which reflected the many years of mismanagement, and (3) finally, the involvement of the West German parties in the campaigns for the March elections. As a result the people in contrast to the intellectuals opted for a swift unification process in the March 1990 elections.

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Relationship Between ON, OFF, and Neutral Cell Activity and Blood Pressure

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One critical area of medicine focuses on ridding individuals of chronic pain. Acute pain often has a positive effect on a person as it warns of danger. If it wasn't for pain, a person would not know his or her limits. For example, if a person was to place his hand on a hot stove, he would immediately remove his hand to avoid damaging it. So pain is an indicator of threat to one's body. However, chronic pain is not necessary to warn of impending danger and can lead to physical and psychological distress. Even today, many forms of chronic pain are not adequately treated. Therefore, scientists are working to find a better way to treat chronic pain without drugs that may have side affects and surgery that do not altogether remove the pain. To find better treatments, scientists must understand how pain is experienced. It is known through studies on laboratory rats that neurons located in the rostral ventral medulla in the brain controls the perception of pain. These neurons are ON, OFF and Neutral cells. ON cells, when active, tend to boost the perception of pain. However, OFF cells, when active, lessen the perception of pain. Neutral cells are another class of neurons that is found but they do not change their activity in relation to pain. It was also discovered that there is a correlation between neural activity and blood pressure. Therefore, the purpose of the experiment is to find the correlation between ON and OFF cells neural activity with blood pressure.

Electrical activity of ON, OFF, and Neutral cells were recorded in lightly anesthetized rats. Cells were classified based on their responses to a noxious stimulus. ON cells were excited by the noxious stimulus, OFF cells were inhibited, and Neutral cells were not affected. Blood pressure was also monitored during these experiments. Results to date have been inconclusive. Some ON cells and some OFF cells have shown electrical activity that is correlated with blood pressure. However, the majority of cells show no correlation.

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The Effect of Distortion on the Performance of Fingerprint Verification Systems

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Digital enhancement of fingerprint images during the enrollment process improves the performance of the verification process. Distortion of fingerprints during the enrollment process degrades the performance of the verification process. We present a design and analysis of a new synthetic discriminant function (SDF) to deal with distortion that is due to rotation and scale variations of the digitally-enhanced fingerprint system. Performance comparison between the proposed SDF and an SDF obtained for traditional fingerprint systems is included.

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Development of a magnetic bead streptavidin-biotin method to isolate proteins from various strains of *Helicobacter pylori* that bind to the arginase promoter

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Helicobacter pylori is a bacterium that causes stomach and duodenum ulcers in humans. Roughly 50% of the world's population is infected by the organism. The enzymes involved in ulcer formation are not well understood. Transcriptional regulation of the arginase gene, a gene responsible for acid resistance and inhibiting T cell responses, is also not well understood. By gaining a greater knowledge of the arginase gene and its regulation, we may be able to develop novel anti-arginase agents to combat *H. pylori* infection. The two strains chosen for the study are WT J75 and WT 26695. These strains are low and high arginase producers, respectively, suggesting a difference in arginase gene regulation between these organisms. *H. pylori* strains were grown for two days and lysed by sonication. The strain specific intracellular components were then incubated with their corresponding PCR-amplified, strain-specific biotinylated arginase promoter region. The mixture was then combined with streptavidin-coated magnetic beads and placed in a rotator. The isolated proteins were then removed from the magnetic bead-DNA complex and analyzed by SDS PAGE. DNA was omitted in the negative control. The gel indicated that there is at least one protein (0305 kDa) that binds the arginase promoter that was not found in the control, suggesting a protein-specific to the arginase promoter has been found. The same protein size was obtained from both strains of *H. pylori*. The protein is hypothesized to be an arginase transcriptional regulatory protein and will be identified by Mass Spectrometry.

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Development of Sulfur Ylide Technology

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Atoms when covalently bound to one another can form cyclic compounds. These systems constitute a unique class of compounds called carbocycles (**Figure 1**). If the carbocycle consists of only three atoms, the system is inherently strained. The strain, commonly referred to as Baeyer strain, makes these systems susceptible to reaction. The most common reaction observed involving three membered rings is a ring opening. Understanding this process is of great interest within the scientific community.

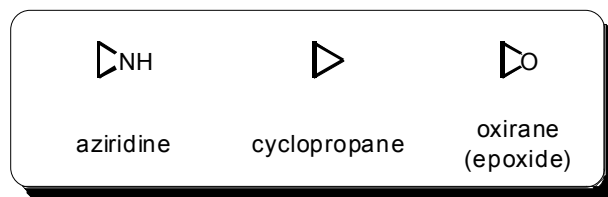


Figure 1. Representative three membered rings

Three membered rings consisting of two carbon atoms and one nitrogen atom, one oxygen atom or once carbon atom are called aziridines, oxiranes and cyclopropanes respectively (Figure 1). Therefore, the synthesis of compounds possessing three membered rings presents a useful avenue for the incorporation of functionality into organic compounds.

Over the past several years, our research activities have concentrated on the development of efficient methylenide transfer agents using sulfur ylide technologies to assemble three membered rings. Presented will be our current findings focusing on the development methylenide transfer agents using a host of unique p-acceptors.

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Investigation of the Impact of Dementia on Family Caregivers

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The goal of this research project was to investigate the impact of dementia on family members caring for People With Dementia (PWD). The data consisted of audio-recorded unstructured interviews carried out with the primary caregivers of PWD. Qualitative methods were used to identify common themes within the responses of the caregiver participants. Caregiver responses were variable, however a common theme emerged. The caregivers all stated that limited information was given by the health care profession in regards to expectancies and methods of dealing with problems associated with the care of PWD.

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Prediction of Impact Sensitivity of Chemicals by Adiabatic Temperature Rise

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CHETAH 8.0©, a computer-screening tool to identify reactive chemical hazards; was used to help explore if a chemical's impact sensitivity can be predicted by calculating the temperature rise associated with the chemical decomposing into lower energy compounds.

Benson's method of group additivity was used in the CHETAH program to calculate enthalpies of decomposition for the compounds to be studied. Using an energy balance with decomposition products selected by CHETAH for maximum energy release, adiabatic temperature rise values were then calculated using MathCAD©. These values were compared to values calculated by NASA'S CET© program that use a different set of decomposition products as well as compared to experimental impact sensitivity data. The predictions were in good agreement. It appears that the hazard indexes predicted by the proposed method have a value as a screening tool. A more extensive set of data needs to be studied to verify these tentative conclusions. The proposed method has the advantage of a very wide range of application in terms of compounds that can be calculated and thus evaluated.

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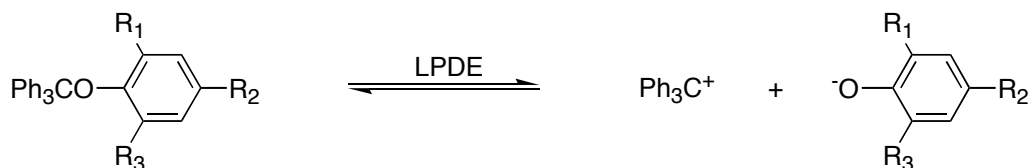
2005

Heterolytic Bond Cleavage of Triphenylmethyl Phenyl Ethers in Solutions of Lithium Perchlorate-Diethyl Ether

Joshua Hollingsworth and Greg T. Spyridis

Department of Chemistry, University of South Alabama

The coulombic fields present in highly concentrated nonaqueous salt solutions furnish powerful electrostatic stabilization of charged reactants, transition states, intermediates and products. Of particular interest is the solvent system lithium perchlorate-diethyl ether, hereafter LPDE. Strictly anhydrous lithium perchlorate is extremely soluble in dry diethyl ether, with solutions up to 6.06 M possible. We propose to probe the ability these media to promote ionization and sustain dissociation by determining equilibrium constants, K_{Ion} , for the following reactions as a function of LiClO_4 concentration:



The extent of ionization will be monitored spectrophotometrically utilizing the intense lemon-yellow color of the trityl cation ($\epsilon = 4.0 \times 10^4 \text{ M}^{-1}\text{cm}^{-1}$ at 430 nm) and the minimum order of participation of Li^+ on K_{Ion} will be obtained.

Over the summer we conducted both semi empirical as well as *ab initio* quantum mechanical calculations on several of the ethers we wish to synthesize in an effort determine the effect of increasing steric bulk at R_1 and R_3 on both the ethereal COC bond angle as well as the C-O bond lengths. In addition, calculations were done to observe the effect of placing electron-withdrawing groups at R_2 on both the ethereal COC bond angle as well as the C-O bond lengths.

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A Study on the Influence of Several Commercially Available Pozzolanic Materials on Portland Cement Concrete (PCC) Properties

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Although pozzolans improve the strength of concrete, their presence may have adverse affects on several other properties of concrete. This study investigated the influence of two commercially available pozzolans (silica fume and ultra fine fly ash (UFA)) on restrained shrinkage cracking of concrete via the use of free shrinkage and restrained ring tests. Results show that an addition of silica fume up to 6% of concrete's weight does not have significant influence on the restrained shrinkage cracking of concrete. On the contrary, an increase of the silica fume content to 9% showed an obvious negative decrease in the age of cracking. The addition of 12% UFA improved the restrained shrinkage cracking behavior of concrete by prolonging cracks by as much as 4 days in comparison to that of plain concrete. A study will soon be conducted to establish other properties of the pozzolanic mixtures of Portland Cement Concrete.

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**Assessing Functional Performance and Mechanical Instability
Characteristics in Subjects With and Without a History of Ankle Sprain**

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South Alabama

Context: Ankle sprains usually involve injury to the lateral ligaments and result in decreased strength and physical performance, increased joint laxity, and/or altered or deficient proprioception in the ankle joint. Some individuals experiencing instability after ankle sprain have no associated ligamentous laxity and others report the presence of functional impairments that might be the cause of the instability. **Objective:** To examine ankle joint laxity and functional performance differences between uninjured and previously sprained ankles. **Design and Setting:** A comparative study conducted in a university human performance laboratory. **Participants:** A volunteer sample of 25 university-age subjects with a history of unilateral ankle sprain. **Outcome Measures:** Instrumented measurements of ankle-subtalar joint complex laxity; isokinetic muscle torque measures of ankle and knee strength; a series of unilateral hops for jumping distance measured functional performance; and a stabilometer measured dynamic postural control using a single leg stance from which an overall stability index was calculated. **Results:** Results of the eversion isokinetic strength measures (Ft-lbs) indicate significant findings for the 60°/s speed ($t_{24}=2.25$, $p=.039$; $M_{injured}=7.82$, $SE \pm .86$; $M_{uninjured}=11.04$, $SE \pm 1.1$) and 120°/s speed ($t_{24}=2.39$, $p=.030$; $M_{injured}=5.91$, $SE \pm .38$, $M_{uninjured}=8.0$, $SE \pm .76$). All other analyses were non-significant ($p>.05$). **Conclusion:** A history of ankle sprain appears to be associated with reduced muscle strength as demonstrated by decreased performance in the eversion isokinetic strength tests. In the assessment or rehabilitation following ankle sprain, ankle eversion strength must be assessed. Additional research needs to be conducted on a large number of normal subjects and competitive athletes with a history of ankle sprain to identify normative values using these mechanical and functional performance tests.

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Gravity Bias or Lack of Sensation?

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The object permanence related gravity bias of squirrel monkeys was investigated. The gravity bias occurs when an organism "expects a falling object to fall straight down irrespective of any obstruction," (Hauser 2001). Previous studies have indicated that terrestrial and arboreal monkeys experience a gravity bias. The present study was an attempt to overcome the gravity bias response by the presentation of a hybrid model based on previous research and repeated exposure. The second goal was to propose that the gravity bias is simply a default response because of a lack of necessary sensory input. It was determined that the first goal was unsuccessful and the second goal needed a new model and methodology.

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**A preliminary survey of the mosquitoes of coastal Alabama with an
emphases on spatial-temporal relationships**

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Mosquitoes (Diptera: Culicidae) are well known for the human suffering, vector-borne diseases, and economic losses that they inflict. Recently, both mosquito vectors (e.g., *O. japonicus*) and mosquito transmitted diseases (e.g., West Nile) have been introduced to the US. The intent of my study was to survey both larval and adult mosquitoes in the coastal Alabama counties of Mobile and Baldwin. Larvae were collected using container traps and adults sampled using carbon dioxide bait CDC traps. The objectives of this study were are to: i) produce a preliminary list of mosquitoes in the coastal areas of Alabama; ii) to examine spatial relationship of several key species to each other iii) determine the level of fungal infection in the larvae ; iv) test adult species for the presence of West Nile Virus. Both larva and adult mosquitoes will be sent to Millersville University, PA for identification. Adults will then be screened for West Nile virus and larvae returned to USA for fungal screening.

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**A Herpetological Survey of a Seepage Ravine Located on the Campus of the
University of South Alabama**

David McCarty and David Nelson

Department of Biological Science, University of South Alabama

A herpetological survey was conducted on a seepage ravine located near the Hillsdale area of the University of South Alabama campus. This survey was conducted in order to attempt to determine the composition of the herpetological community within and around the ravine. Many species of reptile and amphibian were expected, most notable being ground skins, box turtles, two-lined salamanders, and dusky salamanders. A total of 46 specimens comprised of 10 different species were encountered during this study. Species that were encountered multiple times were: *Scincella lateralis*, *Terrapene carolina carolina*, *Rana clamitans*, and *Eurycea cirrigera*. Species that were encountered only one time were: *Anolis carolinensis*, *Nerodia fasciata fasciata*, *Diadophis punctatus punctatus*, *Storeria occipitomaculata obscura*, *Thamnophis sirtalis sirtalis*, and *Desmognathus auriculatus*. Total number of specimens obtained was lower than was expected at the outset of the survey, however, this was likely due to the weather conditions that occurred during the survey period.

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**A Survey of *Arachnids* and *Coleopterans* from two sites
in the Mobile-Tensaw Delta**

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Coleopteran and *Arachnid* assemblages were sampled weekly for six weeks using trap arrays consisting of drift fences, pitfalls, surface tunnels, carpet sections, cover boards, and polyvinyl chloride (PVC) tubing. Sampling took place in two locations on the ledges and uplands adjacent to the Mobile-Tensaw Delta, Mobile County and Baldwin County, Alabama. The primary questions addressed were 1) Does habitat (i.e., plant community) affect insect assemblage?, 2) Are there other environmental variables that play a role in determining insect assemblage? and 3) Are any of the assemblages indicators of forest type.? A total of 119 beetles representing 8 families and 154 spiders representing 8 families were captured. Arachnids were most common at the Mobile-Tensaw Delta Wildlife Management Area (MTDWMA), where 62% of the 152 individuals captured from the site were spiders. At Jacinto Port (JP), 51% of the 121 individuals captured were beetles and 49% were spiders. Individuals from only one *Arachnid* family, *Lycosidae*, were commonly captured at both sites. Individuals from two *Coleopteran* families, *Carabidae* and *Tenebrionidae*, were also commonly captured; *Carabids* were only common at MTDWMA, whereas, *Tenebrionids* were only captured at JP. Although plant communities differed in composition, age and structure, no significant relationships were found between insect assemblage and community type. It is our opinion that a longer study period, with additional sampling from other areas (e.g., arboreal and aquatic habitats), would yield important and significant information. However, such additional sampling is not possible as these study areas are slated for cutting.

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Stress Tolerance in Seagrass

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Seagrasses constitute a group of aquatic angiosperms with a worldwide distribution among estuarine and shallow marine ecosystems. Thus, these plants occupy nearshore environments that are often affected by anthropogenic disturbance, including exposure to high nutrient loads and agricultural herbicides. Because seagrasses represent a threatened and endangered habitat, the potential impact of chemical exposure coincident with other environmental stressors (e.g., high salt, low light, high nutrients, etc.) could be severe. This study examined how well *Thalassia testudinum* (turtle grass), a seagrass native to the Gulf of Mexico, tolerates high salinity and herbicide exposure using Chlorophyll-*a* (Chl-*a*) fluorescence and heat shock protein 70 (HSP 70) as indicators of plant health. Plants were acclimated to 15 or 25 psu and subsequently exposed to 0 or 1 μM concentrations of dichlorophenyl dimethylurea (DCMU). Measurements of fluorescence yield (F_v/F_m) indicated that both high salinity and herbicide exposure resulted in low photosynthetic efficiency in *T. testudinum*; F_v/F_m values declined from ca. 0.750 to 0.320 following a 2-day exposure to high salt and DCMU. Low fluorescence yields were attributed to 1) damage to PSII as indicated by high values for initial fluorescence (F_o) upon DCMU exposure (ca. 734) and 2) reduction in pigment content under high salt conditions. Values for F_m did not vary as a function of salinity or herbicide. Preliminary data suggest that high salinity, when combined with herbicide exposure, acts synergistically to negatively impact photosynthetic efficiency in *Thalassia*. Future studies will include an investigation into the role of HSP 70, a time-course study of herbicide and salinity effects, effects of different herbicide concentrations and effects of other environmental stressors on growth and productivity in seagrass species.

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An Engineering Perspective on the Impact of Mercury on Mobile Bay

Catherine Murray and Manish Misra

Department of Chemical Engineering, University of South Alabama

This report investigates, through an engineering perspective, the effects of mercury on the environment and the impact of mercury contamination in Mobile Bay. The study aims first to educate on the topic of mercury contamination, and second to persuade as to the importance of this education.

The study was based on previous research conducted both locally and globally, and accessed via internet search. The report includes both sources and cycles of the most dangerous form of mercury - methylmercury. Also, the health concerns of mercury are investigated with examples provided from contaminations in Japan and Iraq. Next, global efforts of mercury emission control by several countries, as well as the United Nations, are studied. Finally, focus is placed on mercury contamination in Mobile Bay and the nearby Gulf of Mexico.

It is shown in this study that the mechanisms for the conversion of mercury into the dangerous methylmercury form are only vaguely understood. Also, Mobile Bay and its surrounding areas are shown to be prone to mercury contamination due to its industrial history and its ecological tendency towards methylization. The report recommends further study of methylmercury content in finfish in Mobile Bay and the Gulf of Mexico. In addition, the report recommends the solutions to mercury contamination instituted by other nations be analyzed to determine if they may be adapted to benefit Mobile Bay. Lastly, the report recommends a greater emphasis on mercury education for residents of the Mobile Bay area.

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The Effects of Leisure Education Training on Youth Attitudes Toward Leisure

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The focus of this study was to determine if leisure education training makes a positive difference in youth attitudes toward leisure. It examines the usefulness of the four components of leisure (leisure awareness, leisure social skills, leisure activity skills, and leisure resources) in planning beneficial and satisfying leisure programs for youth. The youth that were assigned to the intervention participated in a recreation program that included 20 one hour long leisure education sessions. The two control groups participated in recreation programs, but did not receive leisure education training.

Intervention Goals:

1. To increase participant's leisure awareness and understanding of the psychosocial outcomes of leisure experiences.
2. To provide participant's with practical leisure experiences and knowledge of traditional and non-traditional leisure activities skills.
3. To increase participant's knowledge of local, state, and national leisure resources.
4. To increase participant's knowledge of acceptable social behavior in leisure setting.

Leisure attitude was assessed using an "Attitude Toward Leisure" questionnaire.

The results of the research data indicated leisure education training may possibly result in increases of positive youth attitudes toward leisure. After acquiring certain leisure skills, knowledge and attitudes, the youth in the treatment group did show greater evidence of positive attitudes toward leisure than the youth in the control groups.

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Digging Out of Trouble: Archaeology and Abjudicated Youth

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Fourteen abjudicated youth participated in an educational and pro-social project based in the archaeology of Mobile during the summer of 2005. These youth were in a Network Aftercare System that transitions them from local residential facilities back into the Mobile community. Two historic sites were tested during five weeks of excavation. The youth continued with lab analysis and the construction of a portable display for an additional three weeks. The quality of archaeological performance was similar to a college field school. Continuous tasks performed in small groups were most effective in keeping the youth engaged. Working with abjudicated youth had unexpected challenges and rewards.

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2005

Characterization of the role of the LpxP palmitoleoyl transferase activity in the Starvation-Stress Response (SSR) of *Salmonella enterica*

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Salmonella enterica serovar Typhimurium is a common cause of food poisoning in the United States. During its transition from different types of environments, it encounters a variety of stresses. In order to survive and cause disease, *S. Typhimurium* must be able to sense and respond to these environmental stresses. One frequent stress encountered is starvation for a carbon-energy (C) source. The response to C-starvation is referred to as the Starvation-Stress Response (SSR). One gene that is believed to be involved in the SSR is the *lpxP* gene encoding a protein that catalyzes the addition of palmitoleate fatty acyl groups to the lipid A portion of the lipopolysaccharide (LPS) component of the bacterial outer membrane. The addition of palmitoleoyl groups make the membrane more fluid allowing for the movement of proteins within the membrane at low temperatures. In *Escherichia coli*, *lpxP* is known to be induced under low temperatures. Recent data from microarrays has indicated that *lpxP* is C-starvation-inducible (CSI) and is under the control of stress sigma factor σ^E encoded by the *rpoE* gene in *S. Typhimurium*. σ^E is essential for the maximal development of the SSR. To determine if *lpxP* is indeed σ^E -regulated and CSI the promoter region upstream of *lpxP* was inserted in front of a *lacZ* gene of plasmid pRS1274. This will then be used to determine if *lpxP* is under the control of σ^E and is CSI by measuring the change in expression of *lacZ* (encodes an easily assayable β -galactosidase activity) under C-starvation conditions in a *rpoE* mutant and wild type genetic background. We have also obtained a $\Delta lpxP::Kan^r$ mutant, which lacks the *lpxP* gene and LpxP activity so that we can determine whether *lpxP* plays a role in the SSR (i.e., LT-CSS and CSI-CR to other stresses) of *Salmonella enterica* sv. Typhimurium.

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2005

The Geology of Piedmont South East

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The southern Appalachian mountain belt is composed of distinctive tectono-stratigraphic units that are (west to east) the Plateau, Foreland, Blue Ridge and Piedmont terranes respectively. This study was focused upon the delineation of stratigraphic units internal to the Blue Ridge- specifically the western Blue Ridge (WBR). The WBR in Alabama trends from approximately Sylacauga to Anniston and continues northeastward into similar rocks in Georgia. The focus of this study was to geologically map stratigraphic units from near the AL-GA state line west and south to near the town of Heflin, Alabama. Stratigraphic units defined and mapped by previous work included (from old to young): 1) Weisner Formation, 2) Shady Formation 3) The Waxahatchee Slate, 4) Brewer Phyllite, 5) Wash Creek Slate, and 6) the Lay Dam Formation. Importantly, all of these formation were recognized and mapped as units within the current Piedmont SE quadrangle study area. Structural and stratigraphic data collected indicates that the contact between the Wash Creek Slate and the overlying Lay Dam is unconformable, and represents a minimum of 40 Ma of uplift and erosion prior to deposition of the lowermost Lay Dam sediments. This middle Paleozoic unconformity (350 Ma; Acadian), the pre-Lay Dam Unconformity (PLDU), is a major structural feature internal to the WBR in the southern Appalachians. Mapping completed during this study has verified the PLDU strike length extends from central Alabama near Montgomery to the AL-GA state line near Tallapoosa GA, a length of approximately 150 kilometers. In the central and northern portions of the Appalachians major regional unconformities are consistently earlier (450 Ma; Taconic).

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2005

The Effects of Innocuous Stimuli on OFF Cells

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Experiments were performed to determine the responses of OFF cells to various stimuli. There are three different types of cells in the rostral ventral medulla that are hypothesized to modulate nociception: ON, OFF, and NEUTRAL cells. These cells are classified by monitoring changes in their electrical activity in response to noxious heat applied to the tail. ON cells are excited by the noxious heat whereas OFF cells are inhibited by it. NEUTRAL cells do not respond to the noxious heat. These cells have different functions in the modulation of pain. ON cells enhance nociception and OFF cells produce antinociception. The function of NEUTRAL cells in the modulation of pain is unknown. Noxious and innocuous stimuli were applied to a rat. Odor, sound, light, and air puffs are examples of the innocuous stimuli used. My hypothesis is that OFF cells will respond to noxious stimuli but not innocuous stimuli if their function is exclusive to pain modulation. Once we isolated a cell's electrical activity and determined that it was an OFF cell, a variety of stimuli would be applied to the rat to observe the effects. The results of this experiment show that innocuous stimuli do affect the activity of OFF cells. Therefore, the hypothesis that OFF cells exclusively modulate nociception is unlikely.

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2005

The Impact of Middle Adolescence on Children Adopted from the Former USSR

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Since 1996, a frightening number of children adopted from the former Soviet Union have met violent deaths at the hands of their adoptive parents. There have been 13 documented cases of deaths. No other known reports of adoptee deaths from other countries exist. Children who spend their sensitive developmental periods (ages 0-3) in orphanages are prone to developmental delays. However, many children overcome these adversities when adopted into the United States.

The reports of the deaths of these adopted children have brought a great deal of focus on the reason they were killed. Adoptions may be halted from the former Soviet Union. Many speculate that the deaths were due to the children's behavior problems. Problem behavior has been studied in adopted children from many countries, but there has not been a study to focus solely on the children adopted from the former Soviet Union. This study will examine predictors of problem behavior from a cohort of children adopted from the former Soviet Union. This will be the third round of assessments on this sample of children who are now in middle adolescence. A standard multiple regression will be performed to evaluate the impact of family environment on the outcome variable of problem behavior. Pre-adoptive risk factors such as low birth weight and time spent in an orphanage will also be entered into the multiple regression analysis. If participation is lower than expected, a pooled, time-series regression analysis will be performed.

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2005

**Torsional Moments in Buildings
Due to Wind Induced Forces**

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This paper discusses torsional wind loads on buildings with a height of fifty feet or greater. The torsion data from a significant amount of wind tunnel tests are examined and compared with the torsion data derived analytically using three published methods. Conclusions concerning the effect of a building's surroundings and shape on wind induced torsion are discussed. Finally, a new method to analytically determine torsion in buildings will be proposed.

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2005

Baseline Testing of a Pulsatile Flow System for Endothelial Cells

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The spectral analyses of heart perfusion pumps have shown dissimilarity in behavior not only between pumps but also to that of the human heart. This difference demands further study of the effects of these 'unnatural' frequency components on human tissue, more specifically the effects on endothelial cells. This research is intended to study the long-term results of a single harmonic pulse on a tissue segment. It is hypothesized that certain frequencies may have adverse effects on the endothelial cells.

The aim of these experiments is to produce a model of a blood flow system that can emulate conditions which occur in the human body. Moreover, it is desired to reproduce the conditions which occur in a situation such as coronary bypass surgery. In order to achieve these conditions, the pressure in the gravity fed system will need to be modeled to match the systemic pressure during the surgery (approximately 50 mmHg). After achieving the desired pressure, a single harmonic will be induced into the system. A porcine carotid artery segment will be placed in the circuit and evaluated over a time span of four to five hours, the approximate time for bypass surgery. Test variables include temperatures of the perfusate and test bath, pH of the perfusate, harmonic frequency, and magnitude of a pressure harmonic.

Six successful baseline simulations have been completed, showing that the test system will allow the analysis of the physiological effects of high amplitude pressure pulses on endothelial cells.

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Wireless Phone, HAC Devices, & DSP Hearing Aid Compatibility

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Hearing aid users often complain of difficulty using digital wireless phones with their advanced hearing aids when the aids are equipped with a T-coil. Hearing aid compatible devices (HAC) are assistive technologies that can improve the intensity and quality of the signal sent from the wireless phone to the hearing aid's T-coil. This study examined how well two hearing aid compatible devices as well as T-coil mode only worked with different digital signal processing hearing aids and two different digital wireless phones. Results showed that for both phones the neckloop was less effective than the T-coil alone while the silhouette was more effective than the T-coil. The Ericsson wireless phone generated significant radio-frequency (RF) interference in the T-coil mode only. This result was expected because this phone is a bar style with an internal antenna, both of which generate interference. Measurements obtained revealed that there is variation in frequency response across hearing aids regardless of phone and mode (T-coil only vs. silhouette vs. neckloop). Results indicate that Audiologists should perform real-ear measures before recommending a specific hearing aid-wireless phone-HAC combination. An upcoming study will be conducted to determine how RF interference affects signal clarity.

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2005

**Understanding Variations in Water Height Data in Context of Causing
Parameters in Mobile Bay**

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Rapid changes in environmental conditions cause the water level in various Bays to vary. Such variations can be attributed to several factors. The tide is usually considered the main contributor to water level. However, it is not the only factor. It is well-known that water height is affected by several factors. These factors include, but are not limited to, freshwater discharge, rainfall, wind speed and direction, and groundwater runoff.

Conventional approaches for modeling the water height utilize regression-based methods to show how these different factors contribute to the water height. Time series analysis of water height data presents its own limitations.

This project introduces a novel concept of using wavelets and multiple levels of data decomposition to show, in much greater detail than regression, how these factors contribute to the water height.

Time series of water height data collected once per hour from Dauphin Island and the Mobile State Docks was used for this project. Tests with wavelet analysis demonstrate superior cause:effect correlation, than as compared to analysis on time series data.

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2005

Nanocomposite Helmet: Design, Processing, and Fabrication

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If nanotechnology is to become the economic driving force of the 21st century, we must train and educate the next generation nanotechnology workforce. The intent of the nanocomposite helmet project is to offer a research opportunity for our undergraduate students.

Carbon nanofibers can be considered as nano-scale reinforcement with the diameters of 60-150 nm and the length of 30-100 μm . They can be manufactured in a continuous vapor phase growth process. They are less expensive than carbon nanotubes and provide a potential low cost method to manufacture nanocomposites. In this project, carbon nanofibers were incorporated into polymer resin, in conjunction with traditional continuous fibers, to enhance mechanical and transport properties as well as performance of polymer composites. The technical challenges of the project lie in the optimal design of the mold and the uniform dispersion of carbon nanofibers in polymer resin. In the project, a composite mold was made by capturing the shape of an existing thermoplastic helmet. Next, functionalized carbon nanofibers were dispersed in water with the assistance of surfactant and ultrasonic sonication to form a stable suspension of carbon nanofibers. The water was removed through the infiltration of the suspension through a filter and the residual carbon nanofibers were then mixed with polymer resin and hardener. Finally, nanocomposite helmet was made by using hand lay-up process. The fabricated nanocomposite helmet is expected to have increased strength, fracture toughness, dimensional stability, resistance to thermal degradation, and fire retardancy. An upcoming study will be conducted to determine the mechanical properties of nanocomposite helmet.

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Characterization of the role of the SixA phosphohistidine phosphatase in the Starvation-Stress Response (SSR) of *Salmonella enterica*

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The *sixA* gene is believed to be involved in the Starvation Stress Response (SSR), which enables *Salmonella enterica* serovar Typhimurium to survive long-term carbon (C)-starvation as well as to develop C-starvation-inducible cross resistance (CSI-CR) to other stresses, e.g., pH and temperature extremes. The *sixA* gene is thought to be C-starvation-inducible (CSI) as well as σ^E -regulated. To determine SixA's role in long-term C-starvation-survival (LT-CSS) two separate 21-day carbon starvation trails were completed to determine the percent survival of the *sixA* mutant compared to that of the *S. Typhimurium* wild type strain. Difficulties were met in attaining consistent results particularly in the case of the *sixA* mutant. During the course of the experiments the *sixA* mutant was clumping as a result of cells "sticking" together, which creates difficulties in accurately diluting the bacterial cultures and determining viable counts. To determine whether the *sixA* gene is CSI and σ^E -regulated (σ^E being a sigma transcription factor encoded by the *rpoE* gene) we plan to construct a plasmid, which contains the *lacZ* gene under the control of the *sixA* promoter. This will essentially allow us to monitor the conditions under which *sixA* is expressed by measuring changes in *lacZ* expression. The *lacZ* gene encodes an easily assayable β -galactosidase activity. However, difficulties have been faced in cloning the *sixA* promoter into the plasmid pRS1274, the plasmid containing the promoter-less *lacZ* gene preventing us from collecting any data. New methods for completing this task are now in progress, as well as plans for further studies on measuring the role of SixA in the SSR (i.e., LT-CSS and CSI-CR to other stresses) of *S. Typhimurium*.

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The Prevalence of Exotic Plants in Southern Alabama

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This plant pest survey encompasses both terrestrial and aquatic species. Sampling strategies have been designed to: document and determine to what extent non-indigenous species are impacting native and protected habitats characterized by limited human access (e.g., protected lands owned by either the State or The Nature Conservancy of Alabama and remote regions of the Mobile-Tensaw Delta) and gather baseline data for exotic/invasive species for Mobile and Baldwin Counties, AL. At present, we have collected preliminary floristic data that suggest several exotic species [of the wetland, emergent and aquatic variety] have established potentially viable populations along the length of the Delta from the confluence of the Mobile and Tensaw Rivers to Mobile Bay. Such species include the highly invasive pest plants: *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Hydrilla verticillata* and *Myriophyllum spicatum*. Mobile and Baldwin Counties encompass 76 USGS quadrants or approximately 348 surveyable blocks. Thus far, observations from terrestrial habitats have been made in 100 blocks (from 35 quads); a total of 4,700 observations and 291 exotic plant species have been documented to date, some of which include the prominent invasives: *Imperata cylindrica*, *Triadica sebifera*, *Ligustrum sinense*, *Lygodium japonicum* and *Pueraria montana*. This initial list of exotic/invasive species will be used in conjunction with data gathered from our ongoing studies of plant communities of the Mobile-Tensaw watershed to determine to what extent non-indigenous species have impacted southern Alabama and how best to predict the occurrence of notable plant pests for the purposes of eradication, maintenance of biodiversity and management of threatened natural resources.

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Using Wavelets to Understand Dissolved Oxygen Variations in Mobile Bay

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After obtaining the profile data from the physical parameters measured in Mobile Bay from July 1st to Sept 24th of 2004, it was determined that the variations of dissolved oxygen (DO) were too complex to analyze using time-scale methods. To understand the dynamics of dissolved oxygen variations it is necessary run wavelet analysis upon the original signal in order to obtain a comprehensive model for DO using a multivariate least partial squares technique. If this is done successfully, the model could be used to analyze DO variations based on the variations in the other measurable variables in a less complicated manner. Wavelets chop up data into frequency components, so that it is possible to analyze each frequency component with a resolution matched to its scale. However, a choice of a wavelet basis function must be decided by trial and error, this function affects the “compactness” of wavelet decomposition. It is necessary to choose a basis function that applies proper de-noising and results in an applicable time-frequency analysis. Observations of the original signal conclude that the model is one dimensional, and the most efficient way of finding a proficient basis function is by using the MATLAB® wavelet toolbox menu and the Wavelet 1-D package. The Daubechies and the Symlets families of functions seem to provide the best results for a proper statistical analysis to take place. SAS institute’s JMP® the statistical discovery software provides a powerful Multivariate Partial Least Squares method for determining a comprehensive model and testing its error against actual measured variable, in this case a specific wavelet transformed DO signal. Once a comprehensive model of DO is found and tested on multiple sets of relevant data signals to prove its reliability, expansive research is needed to discover methods of predicting DO dynamics.

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**The Impacts of Friction on the
Winds of a Modeled Landfalling Hurricane**

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Using output from a numerical weather model, vertical wind profiles and radial-height cross-sections of the wind field in a hurricane were created from set time intervals to help better analyze the storm's structure. In an attempt to help operational forecasters produce more accurate forecasts, these tools were used in this study to examine what effects landfall has on the low-level wind field of a hurricane. The profiles and cross-sections from each quadrant of the hurricane were compared at times when the storm was both offshore and onshore. It was found that as the storm moved onto land, the wind field in the hurricane's eyewall weakened and spread out radially, becoming quite uniform in magnitude at each height level. Furthermore, a ratio of wind speeds over land to wind speeds over water was found to be 0.785 as the hurricane made landfall.

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2005

Study of Sweetener Anions in Ionic Liquids and Transition Metal Complexes

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Past research indicates that the sweetener anions saccharinate, cyclamate, and acesulfamate might be used as carbon dioxide captors when in ionic liquid form with an imidazolium cation. If proven to be true, these compounds could be used in a safe natural gas purification system because of their low toxicity. Also, because of their "green" nature, they can be coupled with certain transition-metal complexes to be used as organometallic catalysts.

We have synthesized and confirmed by proton and carbon-13 NMR, the structures of four saccharin-imidazolium ionic liquids. We used propylmethylimidazolium, butylmethylimidazolium, hexylmethylimidazolium, and octylmethylimidazolium as our imidazolium cations. While we did not make any ionic liquids with the other sweeteners or perform carbon dioxide solubility tests, they will be addressed in future research. We have also made nine transition-metal complexes-- η^3 -4-F-2,6-(OPPh₂)₂C₆H₂-Pd⁺ {Pd}⁺; η^3 -4-F-2,6-(OPPrⁱ)₂C₆H₂-M⁺ (M = Pd, Ni) {M*}⁺; η^3 -2,6-(OPPrⁱ)₂C₆H₃-Pd⁺ {Pd'}⁺; η^3 -2,6-(OPPrⁱ)₂C₆H₃-Ni⁺ {Ni'}⁺; Rh(PPh₃)₂(CO)⁺ {Rh}⁺; η^3 -(PNP)(2-PPRⁱ₂-4-MeC₆H₃)₂N-M⁺ (M = Pd, Ni) {M#}⁺; η^3 -(PNP)(2-PPRⁱ₂-4-FC₆H₃)₂N-Pd⁺ {Pd^S}⁺—which will be sent to two of our colleagues for testing for homogenous catalysis in the ionic liquids we made.

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2005

**Depletion of the DNA repair enzyme, 8-oxoguanine Glycosylase,
Increases Vulnerability of Pulmonary Arterial Endothelial Cells to Apoptosis.**

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Oxoguanine DNA glycosylase (ogg1) is an excision repair enzyme that initiates the repair of 8-oxoguanine (8-oxoG), one of the most common DNA lesions caused by oxidative stress. Moreover, the 8-oxoguanine lesion, oxidative stress, and dysfunction of pulmonary endothelial cells have been linked to acute lung injury. Thus a better understanding of the antioxidant defense mechanism could be significant in developing new therapeutic strategies to treat acute lung injury. The purpose of the present study was to determine that depletion of Ogg1 sensitizes pulmonary arterial endothelial cells to oxidant induced apoptosis. To test this hypothesis we carried out a series of three steps. First Ogg1 was depleted from PAEC using siRNA, and depletion was confirmed by an activity cleavage assay. Second, pulmonary arterial endothelial cells were challenge with oxidant stress using Xanthine Oxidase (XO) and viability of the cells was measured with a cytotoxicity kit. Finally, the presence of apoptotic pathway was measured with a Western Blot for Caspase 3, an apoptotic marker. Consistent with our hypothesis, results illustrated that there was a percent increase in the amount of dead cells after depletion of Ogg1 using siRNA and treatment with XO. Furthermore, the Caspase 3 Western blot results indicated an increase apoptotic activity in XO challenged and Ogg1 depleted cells compared to a lower apoptotic activity in XO challenged and Ogg1 containing cells. Together, the viability/citotoxicity assay, and the Caspase 3 Western Blot results attest the hypothesis that depletion of Ogg1 increases the vulnerability of PAEC to oxidant stress damage and more specifically, that Ogg1 depletion causes PAEC to be more vulnerable to XO induced apoptosis.

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