BIRMINGHAM-SOUTHERN COLLEGE

❖ SENIOR CONFERENCE ❖
April 23 – 25, 2007

Science and Mathematics
Scholarship is the primary product of disciplinary study. In the academic world, scholarship is presented publicly and reviewed by peers. This process of presentation, review, and commentary creates a richer intellectual community for both scholars and the world at large. Scholarship occurs throughout the liberal arts experience, and the culminating piece of scholarship at Birmingham-Southern College is the Senior Conference, a time during which seniors publicly share their research, scholarship, and creativity with faculty and students inside and outside their major.

All students must complete a scholarly senior seminar, interim, or independent study as deemed appropriate by faculty in the major. To demonstrate this scholarship, all students must participate in a Senior Conference prior to graduation.

Adapted from the BSC 2006-2007 catalog

The following abstracts were submitted to Birmingham-Southern College faculty in partial fulfillment for the Bachelor of Science degree. Upon public presentation, I certify that these student presenters have completed their required Senior Conference.

Chair, Department of Biology

Chair, Department of Chemistry and Physics

Chair, Department of Mathematics and Computer Science
Conference Committee
Megan Gibbons, Associate Professor of Biology
Wesley Eddings, Assistant Professor of Mathematics

Financial support provided by the
Merck/AAAS Undergraduate Science Research Program
Genetic Relatedness Accessed by Odor Preferences in *Mesocricetus auratus* and *Mesocricetus brandti*

Ashlei Aboutayeb and Megan Gibbons (Presenting on Honors Day)

Relevant literature indicates that familiarization is the primary and possible sole proximate mechanism that mediates the development of sibling recognition in small rodents. Typically, littermates that are raised together are discriminated from unfamiliar age mates. However, previously unencountered kin may be recognized by their resemblance to familiar relatives through indirect familiarization (odors based on genetic similarity). These olfactory signatures are involved in social recognition and are the product of a complex interaction between genotypic and environmental components. The differential interest of neonatal hamsters was examined using the odors of other neonates of varying relations. I also attempted to identify how important genetic versus environmental influences are in discrimination between individuals of the species *Mesocricetus auratus* (common teddy bear hamster).
The Effect of pH on the Oxygen Binding Affinity of Hemocyanin from the Blue Crab (*Callinectes sapidus*)

Sundeep Alapati and Andrew Gannon (Presenting on Honors Day)

Having a wide knowledge of the physiology of oxygen transporters can be useful for society. An understanding of how various oxygen transporters respond to different physiological conditions may someday help in the creation of artificial oxygen transporters that can be used to make artificial blood. One particular type of oxygen carrier, Hemocyanin, is present in the hemolymph of many invertebrates. The current project characterizes the effect of pH on oxygen binding affinity of hemocyanin from the Blue Crab (*Callinectes sapidus*). Hemolymph was extracted from Blue Crabs then centrifuged multiple times and then dialyzed in buffer solution. The remaining pure hemocyanin was then added to buffer solutions of various pH and an oxygen binding curve was then created. This was done by stepwise additions of oxygen to the solution while simultaneously measuring absorbance with a tonometer.
Glades are natural openings within the forest canopy that typically have shallow, rocky soils and often contain rare plant communities. In central Alabama, the Ketona dolomite glade ecosystem harbors eight endemic and numerous rare or threatened plant species. There have been few or no studies on how soil influences plant distributions in most glade ecosystems including the Ketona dolomite glades. This study examines the influence of substrate size, soil depth, moisture, and pH on species richness and the abundances and distributions of dominant and rare plant species in the glades. Preliminary data suggest that substrate size may be the most significant factor affecting plant distributions, followed by soil depth. Soil moisture (based on a one-time survey) and pH do not appear to be very influential on plant distributions within the glades. These data may be useful in guiding the management and restoration of these plant communities.
Role of Toll-Like Receptors 2 and 4 in Host Response to Components of Microbial Pathogens

Al Aultman, Jannet Katz, Sue Michalek, and Pamela Hanson

Toll-like receptors play a crucial role in early host response against invading pathogens through signaling to the appropriate genes that produce, among others, the NF-κB transcription factor. By doing so, the TLR’s start the first operation stages of the innate immune system, which fabricate anti-inflammatory and pro-inflammatory cytokines. The production of cytokines is a result of specific pathogens binding to their respective TLR. This study focuses on the innate immunity response to *E. coli* which is an enteropathogen involved in the causation of diarrhea and *P. gingivalis* which is an oral pathogen involved in the etiology of periodontal disease. The study also defines the up-regulation of co-stimulatory molecules, CD80 and CD86, which obtain the roles of communicators between cells. The results of the study concluded that *P. gingivalis* operates by binding to both TLR2 and TLR4. *E. coli* was seen to only function when present with TLR4. It was also concluded that TLR4 has a significant function in up-regulating co-stimulatory molecule CD86. By acquiring such knowledge of how TLRs respond to *E. coli* and *P. gingivalis*, the scientific community will be able to manufacture answers on how to prevent the symptoms and effects that similar bacteria have on the human body.
The Role of Phenylalanine 421 and Phenylalanine 422 in the Catalytic Activity of Cholinesterase 1 from Amphioxus

Stephanie Baker and Leo Pezzementi (Presented in Fall 2006)

Rho proteins are a sub family of GTPases which serve as molecular switches that play an essential role in cell division, growth, and motility. Three of the Rho family GTPases show a 85% amino acid identity; yet, they exhibit distinct cellular functions. It is possible that this distinct function is derived from specific binding to a particular GEF. We want to study this specific binding of Rho and GEF’s, in particular we want to find an activator for Rho C. More specifically we want to concentrate our study on position 758 on various GEF’s which seems to have limited interaction with Rho C due to the spatial arrangement created by Ile 43 on Rho C. We hypothesize that if we change Lys 758 to Arg 758, we would be able to restore electrostatic interactions between various GEF’s and Rho C and that the activation would be similar to that between Rho A and various GEF’s. We plan to explore this idea by using various GEF’s along with their specific amino acid sequences to further evaluate the interactions between Rho and their GEF’s and to hypothesize about the role that the amino acid residues have in the interaction between Rho proteins and their GEF’s. We will investigate these ideas using a protein probe which will be used to determine the extent of activation of Rho A and Rho C in mammalian cells. We will then use the observed information to draw conclusions on Rho protein-GEF interaction specificity.
The Role of *Rad1* in *Saccharomyces cerevisiae* Resistance to Cisplatin and the Ruthenium-Based Compound *mer-[Cl_3(tpy)Ru^{III}]*

Emily Banks and Pamela Hanson (Presenting on Honors Day)

Resistance to chemotherapeutic drugs is a major obstacle for the treatment of cancer. One mechanism of drug resistance involves the repair of damaged DNA via the nucleotide excision repair (NER) pathway. Defects in this pathway result in increased sensitivity to some anticancer drugs, including the common anticancer drug, cisplatin. Chemotherapeutic resistance has led to a search for alternative anticancer drugs. Certain ruthenium complexes have been shown to bind DNA and trigger cell death in various cancer cell lines, suggesting the possibility of their use for future anticancer drugs. The purpose of this study is to compare the impact of NER on the cytotoxic ability of cisplatin with that of the ruthenium complex *mer-[Cl_3(tpy)Ru^{III}]* by using *Saccharomyces cerevisiae* as a model organism. Minimum inhibitory concentration (MIC) assays comparing wild type and NER-deficient (Δrad1) strains resulted in significantly different IC$_{50}$ values when the strains were exposed to cisplatin (p-value of 0.002) but no significant difference when exposed to the ruthenium compound (p-value of 0.722). Cytotoxicity assays resulted in higher percent survival for the wild type than for the NER-deficient strain for both drugs at higher concentrations. This study suggests that the NER pathway is involved in cell resistance to cisplatin, but not necessarily mer-*[Cl_3(tpy)Ru^{III}]*. 
Patient Perceptions Regarding the Inheritance Patterns of Cleft Lips and Cleft Palates

Charlotte Beam and Pamela Hanson

Cleft lips and cleft palates account for many of the oral deformities diagnosed worldwide with 1/700 births expressing this defect. The etiology of this defect is still unknown, but research is being performed regularly in an attempt to explain this deficiency. For this study, a survey was constructed and given to individuals that expressed cleft lips with or without cleft palates. This survey was designed to gauge patient understanding of current models regarding the inheritance pattern of this trait. Preliminary observations suggest that most individuals did not receive any kind of genetic counseling regarding the expression of this trait in their families; most people believe that both men and woman are equally likely to express the trait; and finally about 50% of people surveyed did believe that the genes responsible for the trait expressed a recessive inheritance pattern.
Using National Instruments’ LabVIEW to Improve Thermal Lens Calorimetry Experiment Design

Jared Beam and Scott Dorman

Using the LabVIEW environment (National Instruments) and the “G” programming language it is possible to simplify and automate many tedious procedures in the chemistry laboratory. LabVIEW uses virtual instruments (VIs) to collect data and control instruments. Thermal lensing is a phenomenon that occurs when a laser beam is passed through a solvent. This process creates a temperature gradient within the solvent, changing its refractive index and causing it to act in a similar manner as an optical lens. In this experiment the heat capacities of the solvents methanol and acetone were determined by measuring the thermal lensing effect that each displayed. LabVIEW was then used to create a VI to replace an archaic and inaccurate protocol involving estimation of a scaled plot. Heat capacities found using the VI were 72.47 J/mol*K (11.19% error) and 150.75 J/mol*K (20.89% error), which were much more accurate than those found using the old method. Furthermore, this VI would serve as a teaching tool and introduce students to the LabVIEW environment.
A Protecting Strategy for Chiral Separation

Kristen Bentley and David Schedler

The synthesis of carbohydrate derivatives has become a common practice in biochemical research. Various inositol phosphates and inositol phospholipids have been found to trigger a number of complex biological processes. However, the hydroxyl groups of these carbohydrate derivatives pose a problem in the synthesis of enantiomerically pure and regiospecifically protected molecules. While many new strategies have been developed in order to protect the hydroxy groups and separate the enantiomeric products, these reactions can become complex and expensive. Therefore, this project focuses on a new protecting strategy for chiral separation of inositol in which (R)-3-methyl-cyclohexanone acts as a chiral auxiliary and a protecting group. The model substrate, diethoxycyclohexanone, as well as the starting reagent, (R)-1,1-diethoxy-3-methyl-cyclohexanone, were successfully synthesized with overall yields of 16% and 25%, respectively. Future research would involve the addition of (R)-1,1-diethoxy-3-methyl-cyclohexanone to myo-inositol and other carbohydrate derivatives.
Simulated Orbits of Earthlike Planets Around Nearby Stars

Mark Bentley and Duane Pontius (Presenting on Honors Day)

We developed a computer program to calculate multiple-body orbital dynamics and used it to study the orbital evolution of earthlike bodies in extra-solar planetary systems. Our goal was to explore how long a planet could remain within a range of distances from its parent star thought to be habitable based on a simple climate model. During the simulations, the earthlike planets occasionally experienced close encounters with other planets that perturbed their orbits. None of the systems kept the earthlike planet within the habitable zones for significant periods, although some planets were able to maintain their orbits for at least 1 billion years. Orbital eccentricity was the most commonly perturbed characteristic, changing whenever planets had moderately close encounters. Very close encounters also caused changes in the orbits' semi-major axes.
My Experience with RSA

David Bishop and Doug Riley

In this presentation, the focus will be on the RSA public key encryption algorithm and the methods that were utilized to crack the system. The RSA section will review the history of the algorithm, how it works (the mathematical functions that are the basis), and how the algorithm is utilized in the real world. After the RSA method has been discussed there will be a discussion about the Chinese Remainder theorem and what affect it has on RSA. I will then discuss the two main vulnerabilities that I found the algorithm to have and what I did to exploit those vulnerabilities.
The Prevalence of Misdiagnosis in Craniosynostosis and Plagiocephaly Patients: A Case-Study

Megan Blomeyer, Peter Ray, Jeffrey Blount, John Wellons, Nathaniel H. Robin, John Grant, and Leo Pezzementi

Craniosynostosis affects one out of every 2000 to 2500 births, while plagiocephaly is found in 15 out of every 100 births. This retrospective study was conducted to access the accuracy of referring physician diagnosis. The prevalence of the various types of craniosynostosis as well as plagiocephalies among the patients at the Craniofacial Clinic at the University of Alabama at Birmingham Children’s Hospital was noted. The study included 476 patients, 241 craniosynostosis patients and 235 plagiocephaly patients, from 1998 through 2005. The referral diagnosis and craniofacial clinic diagnosis of these patients were compared to determine the accuracy of the referring diagnosis. Any discrepancies were considered a misdiagnosis. This study found that 49% of the craniosynostosis patients were accurately diagnosed compared to only 33% of the plagiocephaly patients. Over the eight years studied, the misdiagnosis among craniosynostosis increased. A correlation coefficient was noted for both disorders. The craniosynostosis and plagiocephaly correlation coefficients were -0.648 and 0.349, respectively. The negative coefficient for craniosynostosis and the small positive coefficient for plagiocephaly show that referring physicians have a problem diagnosing plagiocephaly because they can more easily name it rule out craniosynostosis. Further education is needed to help correct this problem.
A Survey of Acetylcholinesterase Activity in Bryophytes and the Molecular Form of the Enzyme Present in This Plant Group: A Novel Study

Stefan Bourgoin and Wayne Shew (Presenting on Honors Day)

Acetylcholine is a neurotransmitter found primarily at neuromuscular junctions. At these junctions, acetylcholine is broken down by its specific catalyzing enzyme, acetylcholinesterase (AChE). Previously thought to only exist in the Kingdom Animalia, recent studies have discovered traces of AChE present in plant species, most notably the taxa Leguminaceae (legumes), Bryophyta (mosses), and Hepaticophyta (liverworts). AChE has been shown to exist in one of two forms, globular (G form) or asymmetric (A form), with each serving a different purpose and occupying a different location outside the cell which produces them. Asymmetric forms have been found only in vertebrates, while globular forms are found in all other organisms. This study determined whether or not AChE was produced in selected bryophytes, and the molecular form of the AChE enzyme in the moss, Polytrichum commune. A modified Ellman’s Assay was used to determine if AChE was present in these bryophytes. The AChE present in P. commune was characterized using velocity sedimentation rates in sucrose density gradients. P. commune contained a significant amount of AChE based on the Ellman’s Assay. The AChE in P. commune exhibited sedimentation coefficients in sucrose gradients of 11.3S and 22.6S, (corresponds to G_4 and A_{12} forms of the enzyme). A collagenase digestion failed to remove the form having the sedimentation coefficient of 22.6S, indicating that it was not a true A_{12} form of the enzyme. Thus, Polytrichum commune contains the G_4 form of AChE. Questions about the function of AChE in plants remain. However, this study provides insight into the molecular form of the enzyme likely to be present in other plants and additional information about its distribution in the plant kingdom.
(2,3)-Regular Graphs

Kelly Bragan, Catherine Dooley and Barry Spieler (Presenting on Honors Day)

A graph is (2,3)-regular if the union of the neighborhoods of any two non-adjacent vertices has cardinality three. Faudree and Knisley have shown that all (2,3)-regular graphs on eight or more vertices are of the form $K_s ∨ mK_p$ for some $m \geq 2$, $p \geq 1$, and $s \geq 0$ satisfying $s + 2(p - 1) = 3$. This paper describes the twenty (2,3)-regular graphs on fewer than eight vertices, and shows that no other graphs of this size are (2,3)-regular.
The Ventilatory Response of the Aquatic Blue Crab, *Callinectes sapidus*, during Hypercapnia

Jonathan Bramm and Andrew Gannon

The Blue crab, *Callinectes sapidus*, is an aquatic crab that occupies the intertidal area of shores in the Gulf of Mexico and the Atlantic coast. Although primarily an aquatic crab, *C. sapidus* can breathe air when on land during searches for food. This study investigates the physiological changes that occur when crabs acclimated to breathing both air and water are exposed to increased concentrations of carbon dioxide or hypercapnic conditions. After being exposed to various, increasing levels of carbon dioxide, the crab’s heart rate and ventilation rate as well as hemolymph pH and osmolarity was measured. The impedance technique was used to insert wire leads into the gill chambers of the crab to measure ventilation and heart rates. Data was collected with the BIOPAC System and the statistical analysis was done with Microsoft Excel. These results were compared to previous conclusions made about terrestrial crabs to determine if the physiological changes that occur in aquatic crabs can provide insight into the evolutionary changes from marine to terrestrial life.
Bisphosphonate Regulated Differentiation of Primary Human Periodontal Ligament Cells

Brittany Bross, Amjad Javed, Haiyan Chen, and Pamela Hanson

Bisphosphonates are commonly used to treat osteoporosis, where they are suggested to prevent excess bone resorption and promote osteoblastic proliferation. Paradoxically, recent data suggest that prolonged exposure to bisphosphonates may cause osteonecrosis, or deterioration of the gingival tissue and necrosis of the alveolar jaw bone. The human periodontal ligament (PDL) is a specialized connective tissue that attaches the tooth to the alveolar bone. Although its regenerative mechanism is unclear, the PDL has notable ability for renewal and repair, and it is believed that fibroblasts may play a fundamental role in the maintenance and restoration of the periodontal tissue. In hopes of providing insight on the mechanism of osteonecrosis of the jaw at a cellular level, we investigated if the bisphosphonate Actonel has an effect on PDL proliferative potential and differentiation. PDL tissue was isolated from extracted third molars of seven otherwise healthy individuals and processed for 2 weeks until emigration of cells. Expression and functional activity of key transcription factors (Runx2 and OSX) and other osteoblastic marker genes (OP, OC, and ALP) was determined. Results of histochemical analysis show that PDL cells treated with osteogenic cocktail exhibit increased matrix formation and calcification, but do not show typical mineralized nodules. Gene profiling of PDL cells stimulated to osteoblast lineage showed 2-3 fold increased expression of Runx2 and OSX compared to controls. Consistent with this enhancement, markers of early and late differentiation stages were upregulated over a 5 week time period. Taken together, these results suggest that Actonel alters the ability of PDL cells to differentiate into osteoblasts by modulating the expression of master regulatory factors Runx2 and OSX.
A Study of the Contributions of the Iso312 and Phe139 Amino Acid Residues of ChE1 of Amphioxus to Substrate Specificity and Inhibitor Sensitivity

Lance Brown and Leo Pezzementi

Important sites of cholinesterase 1 and cholinesterase 2 (ChE1 and ChE2) from amphioxus that determine substrate specificity and inhibitor resistance have been determined. It is already known that the acyl pocket subsite of ChE1 is defined by Phe422 and Iso312, and it is thought that the pocket of ChE2 is defined by Phe422 and Phe312 in ChE1. Thus, since ChE1 is able to hydrolyze butyrylthiocholine better than ChE2 can, it was hypothesized that because isoleucine is less bulky, the Iso312 of ChE1 allows bigger substrate molecules like butyrylthiocholine to bind in the active site. Using site directed mutagenesis, a ChE1 I312F mutation was made, which showed less substrate specificity for BsCh when compared to wild-type ChE1, indicating that Iso312 in ChE1 is a determinate of substrate specificity. It was also hypothesized that this subsite could be a determinate in inhibitor sensitivity, and the mutant was tested with organophosphate and carbamate inhibitors and changes in sensitivity were observed. Also, the bottle-neck of ChE1 and ChE2 is an important subsite that determines resistance to carbamate inhibitors. It is also hypothesized that Phe139 of the catalytic gorge in ChE1 comprises one side of the bottleneck subsite, and thus is another important determinate of inhibitor resistance. A ChE1 F139M mutation was made, and little change in inhibitor sensitivity occurred. However, present research shows that methionine has the same bulkiness as phenylalanine, and therefore no change in inhibitor sensitivity should have been expected.
The Synthesis of Novel Norbornene Glycosidase Inhibitors using Diels-Alder Chemistry

Matt Burn and David Schedler

The focus of this study is the synthesis of compounds using Diels-Alder chemistry that will have an inhibitory effect on glycosidase and glycosyltransferase enzymes. The involvement of glycosidases and glycosyltransferases in the biosynthesis of the oligosaccharide chains and quality control mechanisms in the endoplasmic reticulum means that their inhibition can potentially be used for the treatment of viral infections, cancer and genetic disorders. The compounds in this study were cycloadducts of maleic anhydride with imidazole, pyrrole, pentadiene, 2-methylimidazole, 2-aminoimidazole and oxazole. These reactants were chosen for their potential to produce an analog that may behave similarly to the oxygen bridge and planar area near the anomeric carbon in the glycosidase and glycosyltransferase transition states. The results of the synthesis and the enzymatic assays will be reported.
A Novel Methodology for the Asymmetric Synthesis of Deoxygenated Sugars

Coty Cantrell and David Schedler

This research plans to use organic synthesis to design a new synthetic methodology for the production of asymmetric, deoxygenated sugars. The novel transformation will provide a viable means of synthesizing a variety of carbohydrates that could be used as mechanistic probes to explain a sugar’s varying affinity for enzymes, lectins and other carbohydrates. This methodology is based on a known deoxygenation reaction, the Barton-McCombie reaction. However, this project attempted to add the element of allowing a physical separation of enantiomeric partners during an intermediate step of the synthetic pathway. Menthol was used in order to develop and optimize a model reaction of the system. A subsequent reaction was performed with the chiral auxiliary (S)-(+)1-iodo-2-methylbutane. The successful addition of the chiral auxiliary allowed for physical separation of the intermediate via thin-layer chromatography analysis. Applying this methodology to such uses as the synthesis of pharmaceutically important molecules would aid in reducing time- and money-demanding steps in the synthetic process.
Finding the Saddle Points in Simplified Poker Games

Alissa Carey, Marcus Dillender and Barry Spieler

Our work expands on a simplified version of a poker game in which only one person, the “professor,” receives a card from a deck of four Kings and four Queens, with the professor winning with a King and losing with a Queen. The other player, the “student,” can either call or fold. We stipulate new rules that allow for multiple ranks, each player to receive a card, general antes and bets, and multiple rounds of betting. With our new rules, we find the saddle points, which allow us to know the equilibrium strategies and the payoffs.
A Comparison of the Proportions of Different Fish Feeding Guilds Inside and Outside of the Sandy Bay-West End Marine Reserve in Roatán, Honduras As an Indication of Ecosystem Change.

John Bence Carter, Jr. and Andrew Gannon

Coral reefs are considered to be one of the most diverse ecosystems in the world. Coral reefs do not only affect marine life, they influence humans also. Coral reefs provide food and economic benefits to people that are inhabited around them. Increased tourism has lead to coastal development, overfishing, sedimentation and nutrient pollution from land that has led to the degradation of the reefs. In efforts to preserve the reef’s natural resources, countries have developed marine protected areas. On the island of Roatán in Honduras, the community has created the Sandy Bay-West End Marine Reserve to help control the decline of the reefs surrounding the island. This project is aimed at comparing the different fish species feeding guilds (categories of feeding behavior) at dive sites inside and outside of the MPA to determine the effectiveness of the reserve. Multiple pairs of divers using the Roving Diver Technique censused fish at selected dive sites inside and outside the Sandy Bay-West End Marine Reserve for fifteen minute intervals at depths of 0-20ft, 20-40ft, and 40-60ft recording the fish species identified at each dive site. Percent sighting frequency and density was calculated from the results of the surveys. These results and data from the REEF Environmental Education Foundation Database were analyzed to determine if there is any significant difference in the proportions of fish represented in the different feeding guilds within dive sites inside and outside the reserve to determine if the reserve is altering the community.
Monitoring the Effects of Two Ether Lipid Drugs on Endocytosis in *Saccharomyces cerevisiae*

Joseph Cox and Pamela Hanson

The purpose of this research was to further characterize the effects of two ether lipid drugs, miltefosine (HePC) and edelfosine, on endocytosis, using the budding yeast *Saccharomyces cerevisiae*, which serves as a model for cancer cells. Although HePC and edelfosine are known for their cytotoxic effects on cancer cells, the mechanism of action of these ether lipid drugs is poorly understood. Berkovic et al (2003) found that HePC and other ether lipid derivatives cause various inhibitory effects on endocytosis, but Zaremberg et al (2005) found that the ether lipid drug edelfosine disrupts the biophysical properties of lipid rafts leading to endocytosis of the essential plasma membrane protein Pma1p. In this study we further characterized the effects of two ether lipid drugs on endocytosis. First, wild type yeast were treated with either HePC or edelfosine and then dyed with the endocytic marker FM4-64. Movement of the dye from the plasma membrane to the vacuolar membrane was visualized. To see if the two drugs were affecting endocytosis of a certain protein, a yeast strain expressing a red fluorescent protein tagged proton pump (RFP-Pma1p) was treated with HePC and edelfosine and the position of the fluorescent protein was recorded.
A Comparison of Invertebrate Indicator Species Frequency and Density in Coral Reef Environments Inside and Outside of the Sandy Bay/West End Marine Reserve in Roatan, Honduras

Kelly Craft and Andrew Gannon

Protection of coral reef environments has become a more pressing issue due to pollution, the massive influx of tourism, sedimentation, coral bleaching, over harvesting, and other factors resulting in damage to the coral reefs, fish, and invertebrates. To counteract the damage done to the coral reef and its inhabitants, marine protected areas are being developed in some of these environments. The Sandy Bay/West End Marine Reserve Park was implemented in Roatan, Honduras in 1989. Several invertebrate indicator species were observed inside and outside of this reserve park over a two week period using the roving diver technique. The data were compiled using abundance categories of single, few, many, and abundant. The percent sighting frequency values were determined, then changed to decimals and transformed using the arcsin of the values before comparison with t-test analyses. The densities of the data sets from inside and outside of the reserve were also compared with t-test analyses. Finally, ANOVA tests were performed for the sighting frequencies and densities of all species inside the reserve as compared to outside the reserve. The species observed with the greatest densities, 2.5 or greater for both inside and outside the reserve, were the Gorgonia ventalina and Pseudopterogorgia spp. The majority of all the indicator species had a sighting frequency greater than 50%. Except for the arthropod sighting frequency and density being greater outside the reserve than inside, there were no other significant differences in the sighting frequency and density of indicator species inside the reserve as compared to outside the reserve. Therefore, it can be concluded that the invertebrate species outside of the reserve have not been more negatively impacted relative to those inside the reserve. For future studies it may be more beneficial to survey fish populations at sites inside and outside of the reserve and continuing studies should be done to determine the health of the coral reef environments inside the reserve.
Differences in Mate Preference and Courtship Behaviors between Wild Type and Defective-Wing Mutants of *Drosophila melanogaster*

Cassie Crauswell and Megan Gibbons

Courtship in *Drosophila melanogaster* is a stereotypic action pattern that is widely studied and one of the best examples of the genetic basis of behavior. The courtship song emitted by wing vibrations of the *Drosophila* male plays an important role in the mating success of this species. However, strains of *Drosophila* without wings or severely impaired wings are still able to reproduce successfully. To investigate this phenomenon, we observed the courtship behavior of *apterous* (wingless) and *vestigial* (impaired wings) mutants of *Drosophila melanogaster* to determine the behavioral modifications that these strains may perform to allow successful courtship. We also conducted choice trials to determine courtship preferences shown by males toward females of each strain. An ethogram was constructed for each strain of *Drosophila* to score the level of courtship behaviors observed during later trials through instantaneous sampling. Next, *D. melanogaster* males (replicates from all three strains) were placed singly with two virgin females of winged and wingless strains to investigate male courtship preference. Initial observations found that *vestigial* wing mutants showed all courtship behaviors seen in wild type flies, despite their severely crumpled wing structure. *Apterous* mutants were found to emit all courtship behaviors except those involving the wings. Unlike wild type and *vestigial* mutants, *apterous* males vibrated their abdomens vigorously while orienting toward the female instead of emitting the usual courtship song. *Apterous* mutants also showed lower intensities of mating behavior than vestigial or wild type strains. Preliminary observations tentatively suggest that wild type, vestigial, and apterous males may show a preference for females with fully functional wings over females with impaired or absent wings. Findings in this study are useful in understanding how adaptations can compensate for mutations that can negatively affect courtship behavior in *Drosophila melanogaster*. 
Montane Longleaf pine communities are characterized by a diverse understory which rely on fire regimes to maintain ecological stability. Data describing the understory was collected from 11 plots, each consisting of a control and experimental, on Double Oak Mountain in Oak Mountain State Park (OMSP), Alabama. In hopes to identify a fire surrogate, litter was raked off of experimental plots and compared to control plots in species richness, percent coverage, stem number, and percent canopy openness. Using the data it was determined by paired, two tailed t-test that stem number was the only tested variable that exhibited a significant difference between subplots (p-value = 0.009 and 0.026). Percent canopy openness was also tested against the three variables and stem number was found to also be the only variable to have a significant correlation with percent open canopy (p-value 0.0092). When tested at the species level it was found that *Acer rubrum* experienced lower stem counts in experimental plots. It was concluded that raking could be a useful fire surrogate to keep invasive species like *Acer rubrum* out of montane longleaf stands. Further research must be done to verify the cause of lower stem counts.
The Role of Translesion Synthesis (rev3) in Resistance to Ruthenium- and Platinum-Based Anticancer Drugs

Katie Dahlene and Pamela Hanson (Presenting on Honors Day)

In order to determine the importance of the translesion synthesis pathway in resistance to cisplatin and the mer-[Cl\textsubscript{3}(tpy)Ru\textsuperscript{III}] ruthenium complex, minimum inhibitory concentration assays and cytotoxicity assays were performed using Saccharomyces cerevisiae. A wildtype strain and a TLS defective strain were both exposed to varying concentrations of cisplatin and ruthenium in order to determine IC\textsubscript{50} values from the MIC assays, and the percent survival from the cytotoxicity assays. The IC\textsubscript{50} for the wildtype exposed to cisplatin was 0.0167mg/ml ± 0.0041, while the IC\textsubscript{50} value for the Δrev3 exposed to cisplatin was 0.0053mg/ml ± 0.0014. For the wildtype exposed to ruthenium and the Δrev3 exposed to ruthenium, the IC\textsubscript{50} values were 0.0097mg/ml ± 0.0033 and 0.0127mg/ml ± 0.0046, respectively. A t-test between the IC\textsubscript{50} values for the wildtype and Δrev3 exposed to cisplatin yielded a p-value of 0.0007, while a t-test between the IC\textsubscript{50} values for the wildtype and Δrev3 exposed to ruthenium yielded a p-value of 0.2059. The results for the cytotoxicity assays were inconclusive. Overall, translesion synthesis appears to be involved in the processing of lesions induced by cisplatin but not ruthenium.
Construction Of A Scanning Tunneling Electron Microscope With A Piezo Disk Scanner

Jack DaSilva and Clyde Stanton

The goal of this research was to build the most advanced type of microscope currently commercially available, a Scanning Tunneling Electron Microscope (STEM). The current price range for commercially available STEM’s is $100,000 to $280,000, while the total cost of this project is expected to be in the range of $1,000 to $3,000. The significant reduction in price is derived from the substitution of critical components with components of slightly less accuracy, but much lower price. A STEM is a microscope that uses electrons to probe the surface of a given object. This particular type of electron microscope uses a principle of quantum mechanics called tunneling. Tunneling is the act of atomic or subatomic particles passing through a barrier of greater energy than the energy of a given particle. This technique allows for resolution in the range of nanometers. Construction of the STEM will be from the base components (operational amplifiers, resistors, and capacitors) requiring soldering, signal input control (control of needle response through selective signal amplification, and signal generation), and circuit trouble shooting. An etching experiment will be performed upon completion of the STEM to test the viability of the STEM tips used by the STEM. A STEM will be a useful tool for Birmingham-Southern College because of its ability to resolve images as small as 10 nanometers in size, perhaps smaller. A wide range of samples could be probed and imaged by a STEM. The simplest would be to scan across the surface of pure metal such as Copper. The expected output would be a grid work of peaks and valleys.
A Model of Camshaft Wear

Michael Donze and Barry Spieler

The automobile today uses a series of cam followers to activate valves in an engine to allow for the intake of air and expulsion of detonated gases. The opening and closing of valves is controlled by various cam follower designs. The hydraulic pushrod engine uses a hardened steel rod to follow a camshaft's lobe and affect the valvetrain respectively. Slack in the valvetrain is controlled by spring pressure applied to the rocker and transferred to the pushrod and camshaft. The pressure between the pushrod and the camshaft can cause wear that can be modeled using a bushing-cam wear system. The change in lift of the actual camshaft from wear can be determined based on the number of revolutions the camshaft undergoes. The model of the resulting camshaft can be used to determine the effects of the camshaft's wear on engine performance.
Factors Associated with the Intent to Perform Safe Behaviors Analyzed to Determine Program Effectiveness

Elaine Duffee and Pamela Hanson

As adolescents have been shown to be among those with the highest risk of transmitting sexually transmitted diseases, including HIV, educational interventions have been implemented in high risk communities to empower youth to make safe behavioral choices. One such national program, referred to as the *Making Proud Choices* program, has been implemented in the Birmingham juvenile detention centers. The two part program explores the knowledge base, attitudes, and beliefs associated with the intent to perform safe and unsafe behaviors linked to STDs and teen pregnancy. Pretests and posttests, incorporating different aspects of the program, are given immediately before and after participation in order to evaluate the program’s effectiveness. Data collected from the fall of 2005 to the spring of 2007 was statistically analyzed. Questions were chosen from different sections of the tests as they addressed participants’ knowledge, beliefs, attitudes, and intentions regarding safe behavioral choices. Twenty four paired t-tests were performed to determine which if any factors associated with the intent to perform safe behaviors showed significant differences between pretests and posttests. Among adolescent females, a significant increase was found in perceived vulnerability regarding unsafe sexual choices. Several limitations were observed with the method in place for evaluating the *Making Proud Choices* program, the most crucial of these being the length of the tests.
The watercress darter, *Etheostoma nuchale*, is a highly endangered species, found in only five springs in Jefferson County, Alabama. A population was recently discovered in Seven Springs, which is located in the community of Powderly in Birmingham, Alabama. Only the very basics are known about this species and its ecological requirements. For instance, the fish is found in highest densities in habitats dominated by watercress (*Nasturtium officinale*). The goals of this project are to describe the condition of the spring and describe the use of different habitats by the watercress darter within the spring. This project explores correlations between population numbers and habitat characteristics (geomorphology, water chemistry, and vegetation) in an attempt to better understand *E. nuchale*’s preferred habitat. While data collection and analysis is on-going, several patterns appear to be emerging. Watercress is found only in slow-moving, well-lit, shallow areas which are most abundant at the springhead. The data from this project will lead to a better understanding of the darter’s habitat, which could help guide the stream restoration project planned for the near future. These data will also be important for long-term monitoring of Seven Springs and may help with monitoring and conservation activities at the other four springs harboring this species.
Hydrolysis Mechanism and Cytotoxicity of NAMI-A Derivatives

Jim P. Ellison and Laura K. Stultz (Presenting on Honors Day)

Ruthenium-based compounds are being investigated as chemotherapeutic agents due to their ability to selectively target cancer cells. The compound, NAMI-A (imidizolium-trans-imidazoledimethylsulfoxide tetrachlororuthenate(III)), has recently gained attention because of its effectiveness on metastatic cell lines. A derivative of NAMI-A that substitutes 2-aminopyridine (2-AP) for the imidazole ligand has been prepared. The hydrolysis mechanism for this complex was studied using $^1$H-NMR and electrochemistry. The mechanism elucidation showed that the 2-AP compound hydrolyzes differently than NAMI-A in solution. Importantly, the 2-AP compound loses the nitrogen based ligand in low pH environments while NAMI-A does not. Further studies have been conducted to determine viability by MTT assay of an oncogenic rat intestinal epithelial cell line after exposure to this drug.
Cardio/Ventilatory Response to Induced Acidosis and Hyperoxia in the Aquatic Blue-Crab, *Callinectes sapidus*

Stephen Flowers and Andrew Gannon (Presented in Fall 2006)

The ventilatory response of aquatic animals is assumed to primarily respond to the amount of O$_2$ present, due to its relatively poor solubility in water. Terrestrial animals are exposed to excess O$_2$ via atmospheric air, and are less sensitive to O$_2$ than to CO$_2$ levels in their blood. To evaluate the relative importance of O$_2$ and CO$_2$ as the primary stimulator for the aquatic ventilatory drive, hypercapnic acidosis was induced in blue swimmer crabs, *Callinectes sapidus*, by injection of an acid solution (dilute HCl in saline – pH 1.7) into their pericardial cavity. Decreasing hemolymph pH should mimic the effects of a build-up of CO$_2$ and H$^+$ molecules. Excess O$_2$ was later introduced to see if response to induced acidosis could be countered with hyperoxia. There was significance ventilatory decreases during hyperoxic treatments, especially in Acid Injection + O$_2$, but also for Saline Injection + O$_2$, indicating ventilatory sensitivity to O$_2$, but not pH. The lack of any significant change in heart or ventilation rates during acid-injection treatments under normal conditions corresponds to the theorized O$_2$ sensitivity, and suggests CO$_2$ (acid) levels do not impact the ventilatory drive. Mean ventilation and heart rates were unexpectedly high relative to previous studies, with respective control (resting) rates at 99±50 bpm and 89±30 bpm in normal environmental conditions, and 110±62 bpm and 95±29 bpm in hyperoxic conditions. Heart rates did not change significantly during treatment, but ventilation decreased by as much as 25% following Acid + O$_2$ treatment, and decreased by 16% following Saline + O$_2$ treatment. Thus, although *C. sapidus* demonstrates oxygen sensitive ventilatory drive, there was no evidence of a response to acidosis as found in terrestrial vertebrates.
A Tryptophan Substitution in the Bottleneck of Amphioxus Cholinesterase Type 2 Does Not Significantly Affect Resistance to Reversible and Irreversible Inhibitors

Clay Foster and Leo Pezzementi

Acetylcholinesterase (AChE) is a serine hydrolase that breaks down the neurotransmitter acetylcholine (ACh) at cholinergic synapses, preventing repeated stimulation of cholinergic receptors. Inhibitors of insect AChE have proven to be effective insecticides, but repeated usage of these inhibitors has led to resistance in many insects. One reason for this increase in resistance is that many insects, including mosquitoes and aphids, have two forms of AChE, one of which is significantly more resistant to inhibition by carbamates and organophosphates. The invertebrate chordate amphioxus (Branchiostoma floridae) also has two AChEs, called cholinesterase 1 (ChE1) and cholinesterase 2 (ChE2), and these enzymes have been used to model insect cholinesterases in other studies. ChE1 is up to 329-fold more resistant to carbamate and organophosphate inhibitors than ChE2, and a previous study found that converting the tryptophan in the bottleneck of the catalytic gorge of ChE1 to a phenylalanine resulted in a significant decrease in resistance to these inhibitors. The current study seeks to validate these findings by reversing the process and changing the homologous phenylalanine in ChE2 to a tryptophan. However, kinetic testing of the mutant ChE2 has revealed no significant change in enzyme activity in the presence of carbamates, organophosphates, and a number of reversible inhibitors. Molecular modeling shows a narrowing of the active site bottleneck in the mutant ChE2, but the bottleneck of ChE1 is still somewhat narrower, indicating a possible size threshold between these active site bottlenecks where the enzyme acquires significant resistance to the inhibitors tested.
The Relationship among Knowledge, Risk, and Behavior Associated with Melanoma among College Students

Katie Fox, Duck-Hee Kang and Jeanette Runquist

Although the risk of sun exposure has been widely publicized, how knowledge about the risk is associated with sun protective behavior and actual melanoma risk has not been widely studied in young adults. Furthermore, it is unclear if there is gender difference in these areas. The objectives of this study were to determine: (a) the relationship between knowledge, risk, and behavior associated with melanoma and (b) gender differences among college students. One hundred seventy-one students, ages 17-24, completed a set of questionnaires. There were forty-six males and one hundred and twenty five females. The overall level of knowledge was high, and out of a possible score of 6.00, the mean was 4.76 ± 1.53. The average sun protective behavior used was 11.75 ± 2.47 out of a possible 20 points. The actual melanoma risk ranged from 2.0 (far below average) to 6.5 (far above average) with the mean risk being 3.61 ± 1.48, which was consistent with an average risk for melanoma. There was a significant correlation between knowledge and behavior (r=0.161, p=0.035), but other correlations were not significant. There was also a significant gender difference in the preventative behaviors (p=0.001): The mean for the behavior was 12.13 ± 2.38 for females compared with 10.74 ± 2.43 for males. Because there is a positive correlation between knowledge and behavior.
In order to learn more about the evolution of acetylcholinesterase (AChE), as well as vertebrate evolution, we investigated the structure of AChE from a deuterostome invertebrate, the ascidian urochordate *Ciona intestinalis*. Sequence analysis and molecular modeling indicate that *Ciona* cDNA codes for the AChE\textsubscript{T} subunit, which has the capacity to produce all three globular forms of AChE: monomers (G\textsubscript{1}), dimers (G\textsubscript{2}), and tetramers (G\textsubscript{4}); and assemble into asymmetric forms in association with the collagenic subunit ColQ. We determined the molecular forms of recombinant *Ciona* AChE by velocity sedimentation on sucrose gradients of AChE-transfected COS-7 cell extracts. We discovered that the primary forms of AChE present inside the cells are globular amphiphilic G\textsubscript{1}, and non-amphiphilic G\textsubscript{4}. Although, *Ciona intestinalis* (like all known invertebrates) does not naturally produce asymmetric forms of AChE, co-transfection of cell cultures with the *Ciona* AChE\textsubscript{T} catalytic subunit and mammalian ColQ gene induced the formation of asymmetric A\textsubscript{12} forms. Collagenase digestion of the A\textsubscript{12} AChE produced a lytic G\textsubscript{4} form. This is the first demonstration that an invertebrate AChE is capable of assembling into asymmetric forms, is important from an evolutionary standpoint as it suggests that the AChE\textsubscript{T} has been highly conserved throughout chordate evolution.
**In vitro Effect of Autogenous Serum on Protease Activity in Normal Canine Tear Film**

Kelly Frey, Jason Clark, and Megan Gibbons

Serum is commonly used to treat ulcerative keratitis, a corneal ulcer, because it contains an antiproteinase that has been found to inhibit the activity of matrix metalloproteinases (MMPs), enzymes that degrade corneal tissue in several mammalian species. Knowing the duration of activity of serum in vitro will be advantageous to veterinary ophthalmology because doctors currently use serum without knowing how long it can be stored without losing effectiveness. This study investigated the effects of canine serum on proteolytic activity of normal canine eyes in vitro and attempted to determine the duration of antiproteinase activity of serum when stored at room temperature (23°C). Gel zymography was used to determine the proteolytic activity of healthy canine tears treated with serum that was stored for up to 14 days. The control gel, which was not incubated with serum, yielded a clear band. However, none of the gels that had been incubated with serum showed any bands. This indicates that serum inhibits MMP activity in normal tears for at least 10 days when stored at room temperature. The results of this experiment provide information concerning the most efficient storage duration of serum for the treatment of corneal ulcers in the clinical setting and, with further research, could have important implications for the treatment of human corneal ulcers.
Regulation of Neuronal Differentiation and Acetylcholinesterase Synthesis in *Mus musculus* Neuroblastoma-2a Cells

Kruti Gandhi and Leo Pezzementi

Acetylcholinesterase (AChE) is an enzyme that breaks down the neurotransmitter acetylcholine (ACh) into acetate and choline at the synaptic cleft, which is the space between the two nerve cells, so that the next nerve impulse can be transmitted across the synaptic gap. Since AChE activity is higher in differentiated cells, fetal bovine serum was used to differentiate mouse Neuro-2a (N2a) neuroblastoma cells. Due to the possible regulation of AChE synthesis in Neuro-2a (N2a) cells by cyclic adenosine monophosphate (cAMP), a pharmacological approach was used to investigate the role of cAMP in the regulation of AChE synthesis. Five cAMP pathway inhibitors and activators were used to modulate PKA signaling, and these include cAMP-rp, KT5720, 8-Bromo cAMP, NKH477, and Forskolin. It can be concluded that AChE activity increases after feeding cells; however, AChE activity in the presence of inhibitors and activators of cAMP production was inconclusive.
Sedimentation and Its Effects on Habitat Choice of the Freshwater Snail *Elimia sp.*

Jennifer Gasbarro and Megan Gibbons

Sedimentation has many negative effects on stream organisms, including covering food sources and smothering the organism such that it is unable to obtain sufficient oxygen. The Cahaba River is home to many rare species including several species of freshwater snails. For this experiment, the freshwater snail, *Elimia sp.* was studied to determine its habitat preference and how it relates to sedimentation. Two separate studies were performed. First, I chose three sites along the Cahaba River, each containing 15 plots. For each plot, I placed 10 snails on an intact rock and a rock that was cleared of sediment. I recorded how many snails were found on the different rocks after 5 hours. The experiment was repeated three times at each site. I also conducted a survey to determine if the amount of sediment was correlated to the number of snails found on rocks. This study involved counting the number of snails on rocks haphazardly chosen from the three Cahaba River sites and then removing sediment from the surface in a 5cm x 5cm square. The sediment density was then correlated to the number of snails found on the rock. In the experiment in which sediment was manipulated, snails showed a significant preference for rocks that were cleared of sediment compared to rocks that were left intact. In addition, there was a significant sediment by area interaction for the number of snails found on rocks. This study suggests that sediment pollution in the Cahaba River could have serious consequences for *Elimia sp.* Further studies should be conducted to investigate the effects of sedimentation on other invertebrate species in this river., high-risk groups should be targeted in the education and screening of melanoma.
Sidestepping the Chinese Room: Aspects of Self-Awareness in a Humanoid Robot

Jason M. Gruber and Marietta Cameron (Presenting on Honors Day)

Self-awareness is a subdiscipline of artificial intelligence that has received some theoretical attention, but few attempts at practical implementation. We present two features implemented in a humanoid robot that are intended as preliminary steps towards self-awareness. The primary feature is a self-awareness oriented exploration of self-recognition. Self-recognition is integral to self-awareness because it allows determination of that which is self and that which is not self. Our approach uses motion in the field of vision as a trigger to save a self image, which can later be compared to other images using a color histogram, pixel counts, and shape context descriptors. In addition, the robot is able to estimate the size of objects based on a previously implemented distance estimation algorithm. After explanations and preliminary results of these features, we close by discussing future extensions of the robot’s functionality and the impact of existing features on the study of self-awareness in general.
The Mobile Generation
Byron Harrison and Lewis Patterson

Mobile devices are at the top of the electronics trend market. No longer are we a culture focused on boom-boxes and tube TVs. We are a generation devoted to mobile devices. Whether it’s for entertainment or productivity, we want every capability possible and with battery power. From portable music players, to wireless email, to watching our favorite TV show on the way to work, we it all, and in one convenient, easy to use package.

This presentation will contain three areas of focus. The first area will be the causes of this mobile revolution. The types of users and why they have become so heavily dependent on mobile devices will be analyzed. Also, it will be shown how these users are driving the market to produce more capable devices, all at lower costs. The major manufacturers and their respective devices will be overviewed as well. The second area will be aimed at the software engineering side of this era. The challenges faced in creating and maintaining the software for these mobile devices will be examined as well as the current trends in practice. There will be an overview of the major operating systems as well as the exterior design of these devices and how the relate to the operation. The final area of focus will be the future of this movement. There is great potential for the market of mobile devices and as their capabilities mature so will their complexity and the intelligence of the user. What this means for the expectations of these mobile devices will be examined as well as what is developing in the immediate future.

This presentation will ultimately provide an overview of the current mobile marketplace, the work that goes into creating these devices and where the market is heading.
A Comparison of Maternal Styles in Western Lowland Gorillas (Gorilla gorilla gorilla)

Lindsey Horton and Megan Gibbons

Like all primate species, Western Lowland Gorillas show extensive maternal care. Female gorillas’ exhibit varying parenting styles, with some individuals allowing extensive exploration by their offspring and others rarely are breaking physical contact. I observed three female Western Lowland Gorillas (between the ages of 9 and 22) with offspring (ranging in age from 7-17 months) at Zoo Atlanta, recording several behaviors that are indicative of maternal care including: time that mother and offspring spent in contact, position of young when traveling with mother, and whether the mother or offspring initiated or broke the contact. Preliminary observations suggest that protective behaviors of gorilla mothers are correlated with maternal age and previous experience with offspring.
Quantum Computing: Past, Present, and Future

Daniel Huggins and Lewis Patterson (Presenting on Honors Day)

Today's field of computer science lives in a binary world of 1's and 0's. However, quantum theory seeks to destroy that convention and enter a new frontier of technology. Harnessing the power of quantum mechanical phenomena, a quantum computer could, theoretically, use superposition (a state in-between 1 and 0) in the form of qubits to make current computing algorithms and processing power obsolete. Whereas current computers are based on a Turing model, in which a machine makes one calculation at a time, a quantum machine could make multiple calculations simultaneously. Much like Babbage's "Analytical Engine" however, a quantum computer exists solely in the minds of the computer scientists and physicists that wish to pioneer this revolution. This presentation will review past research of quantum theory with respect to application in computers and then discuss the practicality of such a machine along with the implications of its eventual existence.
Determining If Deletion of the *HXT9* Gene from Pleiotropic Drug Resistant Strains of Yeast Increases Resistance to Anti-Cancer Ruthenium Complexes

Leslie Inmon and Pamela Hanson

When it comes to treating diseases, drug resistance is a major problem. Understanding how cells become resistant to drugs is the first step towards fighting drug resistance. Gain-of-function, mutations within the Cys6-Zn(II) transcription factors Pdr1p and Pdr3p can result in the pleiotropic drug resistant (PDR) phenotype in yeast. Gain-of-function mutations of Pdr1p and Pdr3p increase drug resistance and cause overexpression of *PDR5, SNQ2, and YOR1*, which are ABC transporter encoding genes. These ABC transporters act as ATP-dependent, drug efflux pumps and can eliminate chemotherapeutic agents from cells. While PDR yeast strains are resistant to many drugs, they are actually hypersensitive to metal-based drugs. This is a new finding, due to the lack of research on PDR yeast strains with metal-based drugs. Pdr1p and Pdr3p have also been found to control the transcription of *HXT11* and *HXT9*, which encode Hxt11p and Hxt9p hexose transporters of the Major Facilitator Superfamily (MFS). Furthermore, *HXT11* and *HXT9* are also overexpressed in PDR yeast strains, and have been shown to make cells sensitive to drugs. In this study, *HXT11* or *HXT9* will be deleted from PDR yeast strains. PDR yeast strains with *HXT11* will serve as controls. The lowest concentration of ruthenium complexes that inhibits the growth of yeast strains will be determined with minimum inhibitory concentration (MIC) assays. We hypothesize that in the absence of *HXT11* or *HXT9*, PDR yeast strains will be resistant to the ruthenium complexes.
The foraging behavior of captive meerkats (*Suricata suricatta*) when given novel, exposed, natural and unnatural foods

Melanie Jobe and Megan Gibbons (Presented in Fall 2006)

The foraging behavior of captive meerkats (*Suricata suricatta*) was recorded and analyzed using video documentation. The animals were exposed to four different groups of foods. These foods consisted of four categories of food: unprocessed (termed natural foods and including foods such as fruits and vegetables), processed (termed unnatural foods and including cereals, breads and other man-made products), exposed foods (that the meerkats had previously been given), and novel foods (that had never been given to the animals). This resulted in four categories: unnatural unexposed, unnatural exposed, natural unexposed, and natural exposed. Data was analyzed using the SPSS program. Protein content and sugar contents of the foods did not appear to be a reliable predictor of foraging behavior. Temperature during the trials likewise showed no significant influence on foraging. While the food exposure did not appear to have a significant effect (*P* = 0.627), food type (unnatural or natural) did display a significant role (*P* = 0.001), with the meerkats strongly preferring the unnatural foods. The interaction between food type and food exposure was very close to significant (*P* = 0.065) as the meerkats preferred the unnatural unexposed foods the most. This suggests that the food exposure did play a minor role in foraging preference, with, but was not as important as food type.
Heme proteins are generally related to the function of oxygen carriers. Hemocyanin (Hc) is an oxygen carrying heme protein that is found within arthropods and mollusks. The active site of hemocyanin contains two copper atoms. The goal of this experiment is to determine the formal reduction potential of hemocyanin and its O2 affinity. Spectroelectrochemistry, absorption applications, and X-ray crystallography experiments have all been previously conducted toward the research of hemocyanin. Previous research suggests that the negative formal reduction potential of hemocyanin is similar to the intracellular heme proteins because of the oxygenated-deoxygenated state of the active site. The average formal reduction potential of hemocyanin was determined to be $-0.158 \pm 0.031$. 
Determination of the Effectiveness of Marine Protected Reserves by Comparing the Diversity of Coral Reef Fish in Protected and Unprotected Sites in Roatán, Honduras

Meghan Kilgore and Andrew Gannon

Coral reef ecosystems provide nutrition, stability, and economic wealth to the communities that surround them. In an effort to protect marine life, many preserves have been created to control various detrimental activities such as the removal of fish, invertebrates, coral and other species. Previous studies have shown the biodiversity of fish populations is positively correlated to the overall biodiversity present in coral reef ecosystems. This project observed and recorded the presence of certain fish species inside and outside of the Sandy Bay-West End reserve in Roatán, Honduras. Densities were recorded as 1=Single, 2=Few, 3=Many, and 4=Abundant for fish observed during each survey. The average fish density ranking inside (1.44) compared to outside the reserve (1.23) was not significantly different. However, two important indicator species, Black Grouper (*Mycteroperca bonaci*) and Spotfin Butterflyfish (*Chaetodon ocellatus*) were observed with significantly (p=2.38E-5 and 0.0155) higher densities inside the reserve. The most abundant fish species was the Blue chromis (*Chromis cyaneus*) both inside and outside of the reserve. Although no overall significant difference between densities inside and outside the reserve was found, the difference between certain species shows that the lack of significance could be due to sampling variance from site to site. These results can be used as baseline data to add to over time to gain a better understanding of the effectiveness of the Sandy Bay-West End marine reserve.
The Role of Bisphosphonates in the Odontoblastic Differentiation of Primary Pulp Cells

Julie Larota, Amjad Javed, and Andrew Gannon

Osteoblasts are the cells responsible for the repair and formation of bone. These cells have been shown to originate from undifferentiated, pluripotent cells. Understanding the differentiation of these pluripotent cells into osteoblasts is of considerable interest to understanding the ability of the body to repair and form bone. In addition, the effects of various drugs, namely bisphosphonates, on the ability to repair and form bone can be better understood. In this study, differentiation of dental pulp cells into odontoblasts were used as a model for the osteoblast differentiation. Odontoblasts are the cells responsible for producing dentin, a hard bone like tissue that comprises a majority of a tooth. Osteoblasts and odontoblasts are thought to be close analogs and studies have shown that their differentiation is similarly regulated via the master gene Runx2 and a number of downstream genes. Thus, this experiment compared normal odontoblast differentiation to odontoblast differentiation in the presence of bisphosphonates in an effort to elucidate the role of bisphosphonates in odontoblastic differentiation. In the first phase of this experiment, the dental pulp cells of two healthy human subjects were induced to differentiate and the activity of Runx2 and downstream genes were analyzed over a five week period. In the second phase of the experiment, differentiating pulp cells were treated with bisphosphonate such that Runx2 and downstream gene activity could be compared to that analyzed in the first phase of the experiment. Results of this study assess the significance of bisphosphonate’s impact on odontoblastic differentiation and ultimately osteoblastic differentiation.
The Comparison of Susceptibility of the Two Morphotypes of Spotted Salamander Egg Masses to Three Aquatic Predators: Do Clear or Opaque Egg Masses Have the Advantage?

Jacob Lindsey and Megan Gibbons

Mature female spotted salamanders, *Ambystoma maculatum*, deposit either colorless or opaque egg masses during late winter and early spring. Whether one phenotype of egg jelly has an adaptive advantage over the other is not fully understood. The goal of this study was to expose the two morphotypes of *A. maculatum* eggs to three aquatic predators, eastern newts (*Notophthalmus viridescens*), bullfrog tadpoles (*Rana catesbeiana*), and caddisfly larvae, to compare their relative susceptibility. One hundred egg masses of each phenotype were collected at Henry Farm Park in Jacksonville, AL in January 2007. An egg mass of each phenotype of similar size and developmental stage was introduced into 60 aquaria containing one of the three potential amphibian egg predators with limited additional food resource. In addition, 15 control aquaria containing no predators and 15 multipredator aquaria containing newts and tadpoles were maintained. Preliminary results suggest that while there was no significant preference exhibited by these predators to either egg mass morphotype, the presence of these predators resulted in fewer days to hatching. The overall mean hatch time of the control egg masses was 24.10 ± 0.96 days while the hatch time for egg masses in the presence of predators was significantly lower at 22.12 ± 0.86 days. It is possible that the presence of predators indirectly affects hatching time of *A. maculatum* egg masses (e.g., increased nitrogen in the water from waste). Further studies on the relative advantages of the dimorphic egg jellies will lead to a better understanding of why these two morphotypes persist in nature, thereby contributing to the current knowledge of *A. maculatum* population and community dynamics.
Herbivory Tolerance of Genetically Modified Drought-Resistant and Wild-Type *Arabidopsis thaliana* in Low and High Nutrient Conditions

Danielle Luther and Peter Van Zandt

Agricultural plants face many abiotic (e.g. drought, low nutrient availability) and biotic (e.g. herbivores) stresses that can have negative effects on productivity. The ability of a plant to maintain its fitness while being subjected to stress or damage is called tolerance. As a strategy for increasing crop production despite the stresses plants face, genetic modification has been introduced, which involves isolating and inserting genes specific for a particular function in plants. However, plants that are modified to be resistant to a particular stressor can, in turn, suffer decreased fitness due to another stressor. In this experiment, *Arabidopsis thaliana*, which is a plant related to agricultural crops and commonly serves as a model organism in genetic modification experiments, was used to compare the responses of genetically modified drought-resistant *Arabidopsis* to its wild-type line after exposing the plants to nutrient-rich and nutrient-poor conditions and herbivores. A preliminary experiment was carried out in which both lines were exposed to various nutrient levels in order to determine a nutrient-rich and a nutrient-poor condition. Next, both plant lines were grown in the nutrient-rich and nutrient-poor conditions and herbivores were placed on the plants to obtain tissue damage. Fitness levels were determined by assessing the seed yield after exposing the plants to the stressors. The findings of this experiment could show that the drought-resistant plants do not exhibit herbivory tolerance even when nutrient conditions are good. On the other hand, the results could demonstrate that being drought-resistant allows a plant to actually perform better when faced with the additional stress of herbivores as long as there is sufficient nutrient availability.
A Prospective, Randomized-Controlled Study of Crestal Bone Loss in Short-Span Fixed Bridge Patients Implanted with the Osseotite® Certain™ Lateralized Implants

Lindsey Marecle, Michael Reddy, and Pamela Hanson

Dental implants serve as artificial tooth roots and have been successful at preventing the physical and cosmetic consequences associated with tooth loss. Impressive success rates for implant restorations are noted in previous studies, but one significant drawback to implant restorations is the resulting crestal bone loss. This loss can be attributed to multiple factors including position of the biologic width of the peri-implant mucosa, presence of a microgap, position of the “abutment” inflammatory cell infiltrate, and design of the implant. Most importantly, it has been observed that crestal bone resorption is reduced with the use of the Osseotite® Certain™ Lateralized implants, which shifts the implant-abutment interface away from the crestal bone. The goal of this study was to compare crestal bone levels adjacent to the control Osseotite® Certain™ Non-Lateralized implants and the test Osseotite® Certain™ Lateralized implants at the times of implant placement and permanent implant restoration. Measurements of crestal bone levels at permanent prosthesis insertion were compared to those at implant placement surgery on the mesial and distal sides of control and test implant types, and the data was analyzed using a mixed analysis of variance. After adjusting for the implant site, the control implant type had greater mean mesial and distal bone losses. The p-values calculated for the mesial and distal bone loss were 0.8497 and 0.4854, respectively. Therefore, although differences were noted between the mean mesial or mean distal bone loss for the test implant type and for the control implant type, the ANOVA revealed the differences were not statistically significant.
Use of Edge Habitats by Free-Ranging Cats and Dogs in an Urban Nature Preserve

Britni Marks and Scot Duncan

Forest fragmentation and urban sprawl have caused an increase in the abundance of free-ranging cats (*Felis silvestris*) and dogs (*Canis familiaris*) in natural habitats. These predatory species can have a dramatic impact on the populations of native species. One consequence of forest fragmentation is an increase in the amount of edge habitat. However, little is known about the use of different types of forest edges by these introduced predators. I used camera traps at baited scent stations to study the frequency of free-ranging cats and dogs using three types of forest edge and the forest interior at Ruffner Mountain Nature Preserve located in Birmingham, Alabama. Three types of edge were chosen: edge adjacent to industrial sites, edge adjacent to neighborhoods of lower housing values (LHV), and edge adjacent to neighborhoods of higher housing values (HHV). The forest interior was used as a control. Data collection and analysis is ongoing, however, preliminary results have been determined. An encounter is considered to be each individual time the camera trap was triggered. Of the total encounters (all native and introduced species), 50% occurred in the HHV edge and 34% in the LHV edge. Of the encounters in the HHV and LHV edges, approximately 10% were dogs and 0-3% were cats. No dogs and cats have been encountered in the industrial edge locations. Overall, 68% of encounters were native species. Raccoons (*Procyon lotor*) were the most common species and made up 40% of the total encounters. The Virginia opossum (*Didelphis virginiana*), Gray Fox (*Urocyon cinereoargenteus*), and Red Fox (*Vulpes vulpes*) were the next most frequently seen native species, but each made up less than 10% of total encounters. At this point, dogs appear to be most common along the HHV edges, while cats appear to be most common in the interior and HHV edges. The final results for this study may help guide park managers in efforts to reduce preserve usage by exotic predators.
The Effects of Osmolarity on Drinking Behavior in the Amphibious Ghost Crab *Ocypode quadrata* Compared to the Aquatic Blue Crab *Callinectes sapidus*

Tommy McCain and Andrew Gannon

Osmoregulation is an energy-expensive process that is composed of both behavioral and physiological actions that allow terrestrial organisms to prevent desiccation and the concomitant increase in hemolymph (blood) ion concentration. Osmoregulation is used by both aquatic and terrestrial crabs, and enables them to successfully balance their ion concentrations. While it has been found by previous studies that land crabs prefer to drink water with the lowest salinity, it has never been investigated as to whether or not the sand present in their water dishes was an intentional addition or not. An experiment was designed to test the water preferences of the aquatic crabs and compare them to those of terrestrial crabs. Both the aquatic and terrestrial crab specimens were given water of four different salinities from which they could choose. They were videotaped for eight hours and subjected to observational analysis so that their behaviors could be used for comparison within their own category (aquatic or terrestrial) as well as cross-examination against each other. The videotaped behavior of the crabs scooping up sand and adding it to the water, using their chelipeds, and the physiological data collected determine four unknown factors: if aquatic crabs have a water preference based on salinity, if the crabs are purposely adding sand to the dishes, if the sand added significantly changes the salinity of the water, and if the osmolarity of the hemolymph remains constant – indicating that homeostasis was maintained. Preliminary results showed that *Callinectes sapidus* has an overall drinking preference for the 700 mmol/kg water, while previous studies have shown that land crabs prefer salinities in the range of 0 mmol/kg to 350 mmol/kg.
Genetic Analysis of Inflammatory Skin Disease in CD18 Deficient PL/J Mice

Kristin McDonald, Daniel Bullard, and Leo Pezzementi (Presenting on Honors Day)

Dr. Bullard’s laboratory has performed genetic and molecular analyses, in order to learn more about the genetic modifiers of inflammatory disorders such as psoriasis, which have identified four different regions on chromosomes 1, 4, 7, and 10 that may contain loci that are important to the development of inflammatory skin disease in CD18 deficient (low expression) PL/J mice. Due to the size of these regions (between 20-30 x 10^6 base pairs), further linkage studies are needed in order to decrease their size and identify candidate genes. An additional 350 F2 mice were analyzed for the development of skin inflammation in order to further decrease the size of the regions that may contain genes that are important to the initiation of psoriasis. These mice were created by breeding CD18 deficient PL/J mice, which are susceptible to inflammatory skin disease, to resistant CD18 deficient C57BL/6 mice. In this experiment, specific polymorphic microsatellite markers that span each of the linkage intervals on chromosome 10 were used to genotype affected and non-affected F2 mice. Another aim of this project is to determine the importance of low CD18 expression levels in T cells for the development of the disease. Transgenic mice expressing the CD18 gene exclusively in T cells will be bred with CD18 deficient PL/J mice for four generations. These mice were monitored for the appearance of skin inflammation to determine whether increased T cell expression of the CD18 gene suppresses or prevents the initiation of the skin disease.
Amphibious crabs are unique for their ability to survive at the interface of ocean and land. They have been shown to display sensitivity to oxygen while breathing water and greater sensitivity to carbon dioxide when breathing air. The mechanism by which amphibious crabs display a change in sensitivity of ventilation is not well known, and this study endeavors to determine if two species of amphibious crab display ventilatory responses to induced metabolic acidosis. Vertebrates are known to respond to metabolic acidosis by hyperventilation and amphibious crabs may behave likewise. Wire leads were surgically placed in the excurrent gill chamber and pericardial cavity of blue swimmer crabs and ghost crabs. The crabs were then acclimated to breathing air, and injected with 1.7 pH hydrochloric acid, in saline, and also saline as the control. Heart rate, ventilation rate, hemolymph pH, and hemolymph osmolarity were measured during each trial period. It was expected that ventilation rate would increase with metabolic acidosis, and when conflicting acidosis with hyperoxic conditions, crabs would respond with more ventilatory sensitivity to acidosis than hyperoxia. Preliminary results for *Callinectes sapidus* show that hemolymph pH decreased from 7.53 to 7.23 when comparing resting periods and acid injections. Metabolic acidosis was therefore induced via pericardial HCl injection. Heart rate was qualitatively observed to increase, and ventilation rate was erratic and needs further statistical analysis. Interestingly, hemolymph osmolality increased, on average, about 42.5 mosm. This suggests branchial ion exchange as compensation for internal acidosis. Whether amphibious crabs possess internal ventilatory receptors for pH change or not cannot be confirmed at this time.
Determination of the Formal Reduction Potential of Wild Type and Various Mutants of Sperm Whale Myoglobin

Patrick Murphy and Pamela Hanson

Currently, the creation of a usable blood substitute for oxygen transport is being investigated. One method is to manipulate iron-based oxygen carrying proteins, such as sperm whale myoglobin, which was used in this study. In order for such mammalian iron-based proteins to function properly as intracellular oxygen transporters they require a negative reduction potential. However, when introduced outside of the cell these proteins become ineffective. The goal of this study was to determine if sperm whale myoglobin could be manipulated to give a positive reduction potential. This could give insight as to whether the protein could function properly extracellularly. The sperm whale myoglobin wildtype, 64A mutant and 64L mutant were tested using spectroelectrochemistry. The mutant descriptions 64A and 64L simply mean that in the amino acid sequence of the protein the 64th amino acid was changed to alanine and leucine respectively. Using the data from the spectroelectrochemistry and following a series of equations the reduction potentials of each sample was obtained. This experiment provides information as to whether these mutations give a positive reduction potential or not, how such a mutation might affect the proteins ability to transport oxygen, and insight on additional mutations to test.
Software Development using the Rational Unified Process

Muneca Oliver and Lewis Patterson (Presenting on Honors Day)

In producing software, several different approaches can be used. This presentation will cover the software development process, specifically the development of software using IBM’s Rational Unified Process (RUP). The main objective is to provide a walkthrough of the RUP and to show examples of finished products. The four RUP phases—Inception, Elaboration, Construction, and Transition, will be covered in-depth along with the nine disciplines of each phase.
Sponge Morphological Diversity as a Predictor of Species Diversity in Protected and Unprotected Coral Reef Areas in Roatan, Honduras

Elizabeth Orr and Andrew Gannon

Sponges are important indicators of the biodiversity within coral reef communities because of the abundance of different species of sponges. The relative species diversity of sponges within a habitat can indicate the health of that habitat, yet species are impossible to identify without causing tissue damage to the sponge. However, sponge morphological diversity has been shown to accurately predict species diversity, so a high sponge morphological diversity indicates high species diversity. In Roatan, Honduras, the Sandy Bay and West End Marine Park has been created to protect the coral reef habitats. This study examines the abundance of sponges and their morphological diversity at dive sites both inside and outside of the Marine Park in order to determine if sites outside the park have been negatively affected by anthropogenic events such as over fishing, sedimentation and pollution. Eight morphologies of sponges were recorded. Average sponge abundance per site was greater inside the marine park, 364±309, while the mean number of sponges found outside the preserve was 280±101; however, the difference in abundance was not significant. The sponge morphological diversity recorded inside the park had a mean H’ of 1.79±0.3, and the sites outside the park had a mean H’ of 1.63±0.1, but this difference was not significant. Based on these results, the sponge morphotype diversity as a predictor of the coral reef community outside of the marine park has not been negatively affected significantly more than that of the sites inside the marine park. This baseline data should be expanded upon in order to continue to monitor the protection of the coral reef communities around the island of Roatan, Honduras, ensuring that these communities continue to remain healthy.
Measurement of the Production of Ru(bipy)$_3^{3+}$ from Ru(bipy)$_3^{2+}$ Using Laser Excitation

Jack Padley and Clyde Stanton

The absorption of light by tris(2,2’-bipyridine)ruthenium(II), causing an excited state and subsequent fluorescence, has been known for many years. This compound has been used in model systems for harvesting solar energy because of the ease with which the excited state ruthenium compound can lose electrons. After absorbing light of a certain wavelength, the excited electron will either lose energy in the form of a photon and fluoresce or the excited electron can be transferred to another molecule or ion creating an oxidized species. This project seeks to determine the difference between the fluorescence and the oxidation rates of tris(2,2’-bipyridine)ruthenium(II) (Ru(bipy)$_3^{2+}$) and tris(1,10-phenanthroline) ruthenium(II) (Ru(phen)$_3^{2+}$). The transfer of electrons to iron (III) was monitored by the change in the absorption of the solution due to the presence of the Ruthenium (III) species. The results of the experiment will be discussed in further detail during the conference.
Montane Longleaf Pine communities are maintained as long-term stable communities by relying on periodic wild fires (or fire regimes) that kill off invasive hardwoods and produce optimal soil conditions by removing a potentially harmful layer of leaf litter. We found that in the Longleaf Pine community on Double Oak Mountain in Oak Mountain State Park, Alabama, that Acer rubrum acts as an invasive and seems to serve as the key species that initiate the seral changes in succession, leading to replacement of the pines by a hardwood forest. At the experimental site on Oak Mountain, 26 randomly selected Acer rubrum seedlings (13 experimental, 13 control) had photosynthetic and transpiration rates measured over a period of 5 weeks to determine if the removal of leaf litter would affect their rates. The manual removal of leaf litter led to a significant drop in soil moisture (p-value 0.0326) and a slight change in the soil pH (p-value 0.00230) for the experimental seedlings. However, the experimental plants showed no significant change in relation to the control seedlings (those with leaf litter) in reference to photosynthetic and transpiration rates, (photosynthetic p-value 0.104; transpiration p-value 0.802). Acer rubrum appears to have the ability to adapt and thrive even under dry soil conditions over a period of weeks. An additional study was conducted on this site which looked at the density of the Acer rubrum population. What is the long-term outlook for this Longleaf Pine community? According to these studies and results from previous studies, this Longleaf Pine community will most likely soon need a prescribed burn to kill of the invasive Acer rubrum and other hardwood seedlings if it is to survive.
A Tryptophan in the Bottleneck of the Catalytic Gorge of an Invertebrate Acetylcholinesterase Confers Relative Resistance to Carbamate and Organophosphate Inhibitors

Raj A. Patel and Leo Pezzementi (Presenting on Honors Day)

Amphioxus, an invertebrate chordate, has two acetylcholinesterases (AChEs), cholinesterase 1 (ChE1) and cholinesterase 2 (ChE2). ChE1 is up to 329-fold more resistant to a variety of carbamate and organophosphate inhibitors, including a number of insecticides, when compared to ChE2. One difference between the two enzymes is at the position homologous to Phe331 in *Torpedo* AChE. In *Torpedo* AChE, this residue is a component of the hydrophobic subsite and defines one side of the bottleneck in the catalytic gorge of the enzyme. In ChE1 the homologous residue is Trp353; in ChE2 it is Phe353. We used site-directed mutagenesis to investigate the proposal that the resistance of ChE1 to inhibition by carbamates and organophosphates was due to this difference, creating a ChE1 W353F mutant to widen the bottleneck. The mutation virtually abolishes the difference in sensitivity to the inhibitors. The ChE1 W353F mutant is only 2-3-fold more resistant than ChE2 to carbamates and is actually 2.5-10-fold more sensitive to inhibition by organophosphates. The differences in resistance are due to different affinities of the enzymes for the inhibitors, not different reactivities. Molecular modeling supports the proposal that the difference in inhibition is due to the width of the bottleneck of the gorge. Our results have implications for insecticide resistance in insects, in particular mosquitoes and aphids.
Effects of Heritability and Diet on Morphological and Behavioral Traits in the Green Treefrog, *Hyla cinerea*

Bobby Peinhardt and Megan Gibbons (Presenting on Honors Day)

Morphological and behavioral phenotypes are typically determined by a complex interaction of heritability and the environment. We conducted a study on green treefrog larvae (*Hyla cinerea*) to determine the relationship between genetic and environmental effects on traits that may be strongly associated with individual fitness, such as time to metamorphosis, mass at metamorphosis, tail length at metamorphosis, survival, and jumping ability. We collected 5 pairs of adult frogs in amplexus, and haphazardly selected 100 tadpoles from each resulting clutch. Each clutch was divided into 20 groups of 5 tadpoles; 10 groups were fed high protein diets and 10 were fed low protein diets. There were significant effects of diet, clutch, and their interaction for both time to metamorphosis and mass at metamorphosis. For tadpole survival, only diet had a strong effect. There was no effect of either diet or clutch on jumping ability or tail length, but these two traits were highly correlated. In this case, we found that while behavioral traits were more variable, the morphological traits were more strongly influenced by heritable and environmental factors.
Identification and Characterization of a Hepc Sensitivity Restoring Mutation in ∆lem3 Saccharomyces cerevisiae

Ben Pendergrass, Mark Van Gerwen, and Pamela Hanson

Hexadecylphosphocholine (HePC) is an antineoplastic alkylphosphocholine drug which is known to inhibit growth of tumors in rats and can also kill breast cancer cells in humans, although the exact mechanism by which it does each is unclear (Pawelczyk et. al. 1993). In S. cerevisiae, the LEM3 gene has previously been linked to the translocation of phospholipids and transmembrane movement of alkylphosphocholine drugs. Therefore, LEM3 has been proven to play a major part in HePC sensitivity—cells that lack the protein encoded by LEM3 show a decrease in drug potency within the cell and are resistant to alkylphosphocholine drugs (Hanson et al. 2003). Previously, a lem3 null strain of S. cerevisiae was acquired and determined to express the HePC resistant phenotype. This strain was mutagenized and a HePC sensitive mutant was selected and determined to lack LEM3 but contain another mutation which restored the phenotype for HePC susceptibility (Crump et al. 2005). The double-mutant plasmid has been isolated and sequenced to reveal several genes, two of which (FMP38 and NOC2) were selected for further study and to ultimately shed light on the concept of multidrug resistance. Plasmids designed to overexpress each of these genes were transformed into yeast, and the resulting transformants were examined to properly identify and characterize the individual gene or combination of genes that restore the HePC resistant phenotype.
Running in the Rain

Wes Porter, Brittany Green, and Barry Spieler

A person walking in the rain is going to get wet. However, the quantity of rain that he or she encounters is dependent on the person’s velocity. We minimized water absorption by finding an optimal walking velocity for various paths, rain velocities, and body models. We modeled a fictional person as a rectangular prism experimenting with its dimensions in order to simulate different body types. Assuming a straight walking path, constant walking speed, and constant rain velocity, there is an optimal velocity that one should travel to minimize soakage. We then acquired a general understanding that allowed us to extend our model to a path which is piecewise linear, curved in certain ways, and/or graded.
A Survey of the Historical Longleaf Pine Density of Oak Mountain State Park, Alabama

Trey Prickett and Scot Duncan

*Pinus palustris*, commonly known as the longleaf pine, is a diminishing species. Once far-reaching over the southeastern United States, they now occupy only approximately 30,000 acres due to logging and forest suppression. As is usually the case for species facing dwindling numbers, proactive management must be implemented to ensure their survival. By studying original old-growth stands, particular growth trends and other characteristics can be established that can help determine management options for second-growth stands. I, in conjunction with Dr. Scot Duncan, have conducted a survey of the historical longleaf pines of Oak Mountain State Park, Pelham, Alabama, in an effort to determine healthy trends of these forests that may be striven for regarding second-growth management. Forestry methods, including DBH measurement, aging, and mapping, have been implemented in addition to determining the original density of these pines.
The Effectiveness of Ruthenium Anticancer Drugs on *Saccharomyces cerevisiae* Lacking MSH2

Avanija Reddy and Pamela Hanson (Presenting on Honors Day)

This study was performed in order to determine whether or not a MSH2 mutant has resistance to the ruthenium complex (mer-[Ru$^{IV}$-(terpy)Cl$_3$]). Specifically, the wildtype and MMR-deficient msh2 genes in *S. cerevisiae* were tested for drug resistance or sensitivity to the ruthenium complex. Results from minimum inhibitory concentration (MIC) assays indicated that both the wildtype and msh2 cell lines were sensitive to increasing concentrations of ruthenium. Both strains required similar concentrations of drug for 50% inhibition of cell growth with IC$_{50}$ values for wildtype and msh2 exposed to ruthenium being 0.009 ± 0.002 and 0.007 ± 0.004, respectively. Furthermore, the p-value for the MIC assay containing ruthenium was 0.58, suggesting that there was no statistically significant difference between then wildtype and msh2 strain. This study has shown that wildtype and the MMR-deficient gene, msh2, respond similarly when exposed to the ruthenium complex.
A Study of the Internalization of BODIPY-labeled Phosphatidylcholine Analogs in Yeast

David Scoville, David Schedler, and Pamela Hanson

Phospholipids play an important role in all forms of life. They are the main component of cell membranes, which provide a barrier against the infiltration of foreign elements into a cell. In membranes, these phospholipids form a bilayer, with the interior of the bilayer containing the hydrophobic fatty acids and the exterior containing the hydrophilic head groups. These phospholipids are not stationary, however, and within their own monolayer, they are constantly undergoing random motion. Phospholipids can also travel from the outer monolayer to the inner monolayer and vice versa. Phospholipids with fluorescent groups attached to them have been used for a long time to study this movement, and specifically the mechanism by which the phospholipids are transported from the outer monolayer to the inner monolayer in the plasma membrane, resulting in internalization. However, Elvington et al. reported in 2005 that the type of fluorescent group used would affect the method of this internalization. Specifically, they looked at the transport of fluorescent analogs of phosphatidylcholine (PC), one of the predominant phospholipids in all cells. They measured fluorescent PC uptake in yeast cells lacking the *LEM3* gene, a key regulator in phospholipid uptake. They discovered that PC tagged with the larger 4,4-difluoro-4-bora-3a,4a-diaza-s-indacene (BODIPY)-based fluorophores showed increased uptake in *Δlem3* yeast, while smaller fluorophores such as 7-nitrobenz-2-oxa-1,3-diazol-4-yl (NBD) showed decreased uptake. In our study, we used a smaller BODIPY fluorophore with different carbon spacers to determine its effects on fluorescent phosphatidylcholine uptake.
The Contribution of Aromatic Residue Tryptophan 109 of the Choline Binding Site to the Catalytic Efficiency of Amphioxus Cholinesterase Che2

Abha Soni and Leo Pezzementi

Acetylcholinesterase (AChE) is an enzyme that rapidly hydrolyses the neurotransmitter acetylcholine (ACh) at the cholinergic synapses. Currently, AChE research is valuable in developing treatment strategies for illnesses associated with a loss in cholinergic activity, such as Alzheimer’s and Myasthenia Gravis. In addition, this research has a practical application in the agropharmaceutical industry. Due to the ubiquity of its cholinergic transmission across the animal kingdom, this enzyme is being systematically investigated to determine its evolutionary relationships amongst vertebrates and invertebrates. In the present study the known structures of vertebrate AChE have been utilized in hopes of better understanding and modeling invertebrate cholinesterases. Amphioxus, an invertebrate chordate, possesses two cholinesterases, ChE1 and ChE2. Invertebrate and vertebrate models of cholinesterases (ChEs) are utilized to compare and contrast the similarities and differences found in the molecular conformation of these enzymes. This project specifically studied the choline binding subsite in ChE2 and compared its function to that of Human and Torpedo AChEs. One of the three amino acid residues comprising the choline binding site was studied in particular: Tryptophan 109. Preliminary results suggest that an aliphatic mutation of the Tryptophan 109 residue causes a significant decrease in the catalytic efficiency and stability of the enzyme.
Formation of Glycosidase Inhibitors: An Organic Synthesis of Transition State Analogues

Jenny Turnham and David Schedler

Glycosidase enzymes are essential to many biological processes as they are responsible for cleaving the glycosidic linkage of polysaccharide chains. Inhibitors of these enzymes have many potential medicinal applications due to the various roles glycosidases play in the body. Recent studies have shown that transition-state analogues of glycosidase enzymatic reactions are incredibly potent glycosidase inhibitors. This study tested new synthetic pathways in order to yield potential glycosidase inhibitors through reactions of furan with maleic anhydride and maleimide. The study successfully produced two isolated oxo-norbornene core analogs, exo-cis-3,6-endoxo-Δ⁴-tetrahydrophthalic anhydride and exo-cis-3,6-endoxo-Δ⁴-tetrahydrophthalic imide, one mixture of the endo and exo isomers of cis-3,6-endoxo-Δ⁴-tetrahydrophthalic anhydride, and one potential glycosidase inhibitor, cis-oxonorbornene-2,3-diethyl alcohol. ¹H-NMR, ¹³C-NMR, and infrared spectroscopy were used to verify the structure of the products.
The Synthesis and Characterization of Ruthenium(II)-based, 2-(phenylazo)pyridine Anticancer Drugs

Lauren Walker and Laura K. Stultz

Ruthenium-based metallopharmaceuticals have been a promising source of cytotoxicity since their discovery in the late 1970’s. They have been found to be active against a series of tumor cell lines with lower occurrence of side effects. α-[Ru(azpy)_2(Cl)₂] [azpy=2-(phenylazo)pyridine] was tested, but found to be insoluble in water, so research expanded to its other isomers as well as ruthenium-based drugs with alternate ligands. One of the most common analogs used has been α-[Ru(azpy)_2(NO₃)₂] and related compounds because of their encouraging cytotoxicity, solubility, and chemical properties. Previous studies by our group have been done to synthesize and characterize some of these ruthenium-based anticancer drugs, including in vitro studies with yeast; however there is a need to obtain larger quantities of yield and purer product during each step of synthesis. Each complex synthesized was characterized by ^1H NMR and compared to results from previously published literature. In comparison to our group’s previous work, it seems that these experiments did not produce as much product, but the results were more pure than the previous techniques.
Multidrug resistance (MDR), the simultaneously developed resistance to multiple unrelated drugs, is a phenomenon that often arises during cancer treatment. This resistance is usually caused by overexpression of the ATP-binding cassette (ABC) transporters, a family of membrane transporters that use energy generated by ATP hydrolysis to actively pump drugs out of the cell. In the budding yeast Saccharomyces cerevisiae, the pleiotropic drug resistance (PDR) genes PDR1 and PDR3 encode two transcription factors that regulate ABC transporter expression. When gain-of-function mutations arise in PDR1 and PDR3, ABC transporters are overexpressed causing treatments with organic drugs to lose their efficacy as intracellular drug concentrations decrease. Although resistant to a diverse array of toxic organic compounds, pdr strains are hypersensitive to metal-based drugs. Two hexose transporters HXT11 and HXT9 have recently been identified as being under the control of PDR1 and PDR3. It has been demonstrated that their expression increases sensitivity to cycloheximide and several other drugs, and their deletion increases resistance to those same drugs, a trend directly opposite of that exhibited by ABC transport proteins. Ultimately their manipulation may allow the resensitization of drug-resistant cells. In this paper, the role of HXT11 is examined by determining minimum inhibitory concentrations (MICs) of metal-based chemotherapeutic drugs for PDR mutants lacking HXT11.
Species richness is the simplest measure of biodiversity because it represents the number of different species that live in a particular area. This measurement is important to researchers because it indicates which environments contain favorable conditions for the prosperity of many different species. The purpose of this study was to evaluate different landscapes and to determine what abiotic conditions are more favorable for greater snake species richness. I placed 4ft x 4ft artificial cover objects in three area types (open, edge, and forested) at the Birmingham-Southern College Ecoscape and Ruffner Mountain in Irondale, Alabama. Artificial and natural cover objects were checked at least twice per week at each site, and temperature, date, time of day, weather conditions, cover (forest openness), and humidity were recorded for each capture. Few studies have compared the snake species richness between geographically and biologically similar sites, while also accounting for differing microhabitats. Therefore, the results of this study may provide insight into what abiotic factors influence snake species richness, and may have implications for conservation of threatened snake species.
Effects of Herbivory on *Arabidopsis thaliana* Genetically Modified for Drought Resistance

Alicia Weyler and Peter Van Zandt (Presenting on Honors Day)

Herbivory tolerance can be defined as the degree to which a plant can maintain a level of reproductive success in the presence of herbivore damage comparable to the reproductive success of a non-damaged plant. This study sought to assess the viability of a genetically modified line of *Arabidopsis* when placed under normal stresses a crop would experience, specifically herbivory. Once a functional drought-resistant plant line is produced, this research can be applied to more economically important plants and prevent further crop loss due to drought. *Arabidopsis thaliana* is a member of the Brassicaceae or mustard family and is commonly used to study traits related to agriculture because of its small size and short life cycle. Recent researchers have performed various genetic modifications on *Arabidopsis* yielding gm plant lines that exhibit drought resistance when compared to the wild-type lines. In a preliminary experiment, three drought-resistant gm lines of *Arabidopsis* were examined against their respective wild-type lines to determine which gm line was the most drought resistant. AVP, a genetically-modified line from the Columbia wild-type, was determined to be the best drought-resistant gm line and was subjected to a herbivory tolerance study using *Spodoptera exigua*, the beet armyworm, focusing on reproductive fitness after herbivory. Seed production was delayed in the second experiment for AVP when compared to seed production in the preliminary experiment, and the experiment could not be carried out to completion due to time limitations. The shift to later bolting time and seed production during the herbivory experiment raised more research questions related to the effect of herbivory on bolting times as a result of genetic modifications.