

**Biology (and Biology related collaborations) student
abstracts 2015**

**(Use the Ctrl + F keys to search for particular keywords or
faculty)**

**Mate choice of *Gambusia affinis* females in a male-dominated
mating system**

Ibironke Aina and Megan Gibbons

Mate choice is a mechanism of sexual selection in which members of each sex select a mate depending on preferred traits or attractiveness. Live-bearing Poeciliid fish of the genus *Gambusia* mate primarily through forced copulation; therefore, female mate choice does not appear to play as large a role as it does in other species of fish. However, in a study on *Gambusia holbrooki* (eastern mosquitofish) females demonstrated mate choice when they had just given birth, were virgins, or deprived of males for an extended period. For this study, we determined the preferences of 20 *Gambusia affinis* (western mosquitofish) females that had been isolated for two months by allowing them to associate with large versus small males of *G. affinis* that were alone or in a group. The following six conditions were tested: the preferences for the females for, (a) one large male or one small male, (b) three large males or three small males, (c) one small male or three small males, (d) one large male or three large males, (e) one large male or three small males, and (f) one small male or three large males. We hypothesized that if females of *G. affinis* that have been isolated from males show mate choice, then females would chose to associate with large males over small males and groups of males over single males. This study may explain the importance of female mate choice for a species in which it has been considered absent due to the prevalence of forced copulation.

Characterizing the Domains of RIAM Responsible for Tetramer Assembly of Soluble Cholinesterases

Mohamad Babi and Leo Pezzementi

Soluble human butyrylcholinesterase (hBChE) in blood serum helps protect acetylcholinesterase (AChE) from inhibitors like organophosphates (OP) found in pesticides and chemical warfare agents. It is currently difficult to obtain or produce stable BChE in the tetrameric form. Hence, gaining a better understanding of tetramer assembly in hBChE can lead to production of effective BChE as treatment or prophylaxis of OP poisoning. The tetrameric form of anchored cholinesterases (ChEs) has been identified as four ChE subunits with C-terminal WAT domains interacting with the proline-rich attachment domain (PRAD) of anchoring proteins. However, tetramer assembly of soluble ChEs is still not fully understood. Recent studies suggest that proline-rich sequences derived from proteins such as lamellipodin (Lpd) are involved in the assembly of soluble, tetrameric ChEs found in serum. Co-expressing hBChE and *D. viviparus* AChE (DvAChE) with Lpd led to a dose-dependent increase in tetramer assembly. The same occurred when ChEs were co-expressed with another related protein RIAM (Rap1-GTP interacting adaptor molecule). These results led us to believe that WAT-PRAD interactions between the proline-rich sequences of these proteins and soluble ChE subunits are responsible for tetramer assembly. We characterized this putative interaction by co-expressing different truncated RIAM constructs containing proline-rich and proline-poor domains with hBChE and DvAChE. We found that the proline-rich domains of RIAM, especially the longer region near the C-terminal, promoted greater tetramer assembly than the proline-deficient domains. Furthermore, our results suggest that the pleckstrin-homology (PH) domain has a negative effect on the ChE tetramer assembly induced by the proline-rich regions of RIAM.

Revision of Organic Substitution Laboratory Protocol and Analysis of Instruction Pedagogy in the Undergraduate Chemistry Laboratory

Elizabeth Alicia Balley and David Schedler

This study outlines several chemistry laboratory practices and offers a new laboratory experiment adopted by our institution's chemistry department that utilizes a combination of these practices. Organic chemistry is an undergraduate course taken by many students in the sciences and not just those seeking a chemistry degree. The intense course material in combination with its real world applications makes organic chemistry a vital experience for students planning a future in the physical sciences as well as medicine. A student's ability to learn and retain organic principles sets them up for either success or failure. The correct method for instruction and organization of undergraduate organic chemistry laboratory has been widely debated for years. The academic community is beginning to see a shift from traditional, expository experiments to inquiry based procedures. It has been observed in recent years that the Organic Chemistry Laboratory Project 4, S_N2 and S_N1 Mechanisms: Determination of Characteristics of Reaction Order has provided insufficient results. This negative outcome produces a superficial understanding of the subject material and inhibits long term retention. In this study, the laboratory experiment was analyzed for substrate ineffectiveness and procedure technique. Using experimental data, an understanding of the reaction mechanism and kinetics, as well as a combination of laboratory teaching technique, a new procedure was developed for implementation in the fall of 2015.

Determining the role of *gea1* in regulation of Golgi homeostasis in *Schizosaccharomyces pombe*

Andrew Barnes and Melanie Styers

Membrane trafficking is essential for eukaryotic cells to deliver proteins and lipids between membrane-bound organelles. Proper transport of materials between these organelles requires formation of vesicles, which requires recruitment of coat complexes, such as coat protein complex 1 (COP-1). Recruitment of these coat proteins is mediated by ADP-ribosylation factors (ARFs), which are activated by guanine exchange factors (GEFs). GEFs catalyze the exchange of guanosine diphosphate (GDP) on the ARF and replace it with guanosine triphosphate (GTP). Previously, the human GEFs, GBF1, BIG1, and BIG2, have been shown to play important roles in anterograde and retrograde traffic to and from the Golgi. Based on sequence analysis, *Schizosaccharomyces pombe* possess three large homologous ARFGEFs: *gea1*, *sec71*, and *sec72*. Our goal was to characterize the function of ARF GEF, *gea1*, in *S. pombe*. We propose that *gea1* works with the COP-I coat protein to regulate Golgi homeostasis in fission yeast. We have begun to explore the function of *gea1p* using the dominant negative mutant E643K. This charge reversal mutation in the Sec7 domain allows the ARF to bind to the GEF, but does not allow for GDP-GTP exchange. By staining cells with the fluorescent dye BODIPY-FL-C₅-ceramide, we have found that overexpression of either wildtype *gea1p* or the *gea1*-E643K mutant causes Golgi fragmentation. We have also begun studies to tag the epsilon subunit of COP-I to further explore the role of *gea1p* in recruitment of this coat. These studies should lead to interesting and novel insights regarding ARFGEF function in fission yeast.

A New Diagnostic Technique for Prostate Cancer

Taylor Bassett and David Schedler

Prostate cancer is the second leading cancer in terms of worldwide incidence among men. In fact, prostate cancer is the second leading cause of cancer mortality in men and the number of mortalities is on the rise. It is estimated that in 2015 there will be about 220,800 new cases of prostate cancer and about 27,540 deaths from prostate cancer. The current diagnostic techniques for prostate cancer often lead to over diagnosis and overtreatment of the patients. The purpose of this project is to look at a new possible diagnostic technique for prostate cancer. The new diagnostic technique that is being explored in this project is the synthesis of a molecular tracer, called IVCrot, that binds to the enzyme α -methylacyl-CoA racemase, or AMACR, which has been shown to be up regulated in prostate cancer. This tracer has been shown to be a competitive inhibitor for the enzyme AMACR. If more studies are conducted on this inhibitor of AMACR and it is proven effective, then a PET scan can be used to determine the amount of AMACR present in the prostate. This could lead to a higher confidence level in the diagnosis of prostate cancer.

Determining if Moth Proboscis and Body Lengths Can Determine Species Potential as Plant Visitors

Caleb Bonds and Peter Van Zandt

Previous studies have shown some moths function as pollinators. So far it is not understood why some moths function as pollinators while others do not. One previous study on butterflies showed that nectar feeders possessed longer proboscis lengths than non-nectar feeders. The aim of this study was to determine if this pattern might also exist for moths and function as an indicator of flower visitation. In order to do this three moth species were swabbed for pollen grains using a staining gel and looked at under a light microscope. The proboscis and body lengths were measured for these three species as well as for 20 previously sampled species. The species were then separated into two groups based upon the percentage of pollen carrying moths found. Both were found to have an allometric relationship where an increase in body length corresponded to an increase in tongue length similar to the study on butterflies. However, the relationship between the flower visiting moths and non-flower visiting moths was found to be similar unlike the relationship between nectar and non-nectar feeding butterflies. This could have been the result of the small sampling size of data currently available. Another possibility is that there is no difference in their allometric relationships. With more data the relationship could be better defined for visiting and non-visiting moths.

The Effect of Geology on Montane Longleaf Pine (*Pinus palustris*) Ecosystems

Dre'Shun Buford and R. Scot Duncan

Prior to European colonization, longleaf pine (*Pinus palustris*) woodlands dominated 37 million hectares of the Southeast. After over a century of unsustainable logging, land use conversion, and fire suppression, this ecosystem remains in only 3% of its original range. In many surviving stands, fire suppression has allowed broadleaf trees to invade and out-compete pines and understory vegetation. Oak Mountain State Park (OMSP) in Pelham, Alabama, preserves portions of the montane longleaf pine ecosystem (MLPE). This ecosystem has been poorly studied relative to longleaf ecosystems of the coastal plain. The OMSP stands have endured logging and decades of fire suppression. We investigated how geology shapes the MLPE at the park. We hypothesized that geologic and topographic differences between the steep mountainous zones and the lower elevation hills (hereafter “ridge” and “foothills” zones, respectively) are differentially affecting successional dynamics of the park’s MLPE. We measured soil depth, slope, longleaf pine juvenile abundance, and tree species richness in twenty 20x50-m plots that are part of a long-term study. There were 10 plots per zone, with each subdivided into 10x10m subplots that were the units for our analyses. Soil depth and tree species richness were significantly greater in the foothill than the ridge zone. Slope and juvenile pine frequency were significantly greater in the ridge than the foothills zone. Regression analyses suggested that slope and soil depth influence successional dynamics of the MLPE, but differently in each topographic zone. Our findings may aid managers planning the preservation and restoration of the MLPE.

Age at Death Determination of *A. africanus* Dental Remains Using Eruption Sequences

Reed M. Butler and Jason Heaton

The Sterkfontein paleoanthropological site (South Africa) has yielded a substantial collection of hominid remains that have permitted insight into the morphology and behavior of species ancestral to our own. Studying the paleodemography, the distribution of a population's age at death, is pertinent to our understanding of human evolution. Accumulations of skeletal and cranial remains in the Sterkfontein deposit are believed to have occurred through carnivorous predation, as tooth marks present on many specimens and the overall distribution pattern of skeletal remains are characteristic of extant carnivores. The bones are preserved by fossiliferous breccia, but due to predation and a slow rate of degradation, they are often found in fragmentation, making determination of age at death difficult. Teeth, on the other hand, are particularly well preserved due to their dense composition, yet very few specimens belonging to our species of interest, *A. africanus*, have been aged using tooth eruption sequences. Here, we use a system of age estimation based on hominid eruption characteristics, as constructed by Kuykendall (2003), to determine the age at death of *A. africanus* pre-molar and molar specimens recently collected from Sterkfontein. Our results indicate an age distribution from 2.5-8 years, with an average age at death of 5.1 years. The youthful composition of our sample is thought to be secondary to predation by large carnivores, and lack of matching post-cranial remains is attributed to the failure of soft juvenile bones to preserve.

Role of proline-rich regions of RIAM (Rap1-GTP-interacting adaptor molecule) in assembling ChE tetramers

Kyle Cain and Leo Pezzementi

Acetylcholinesterase (AChE) and Butyrylcholinesterase (BChE) are two evolutionarily-related members of the serine hydrolase enzyme family. Acetylcholinesterase (AChE) is one of the most important enzymes in the human body as well as the central nervous systems (CNS) of mammals and many invertebrates. Butyrylcholinesterase (BChE), a secondary ChE used in detoxification, has recently been demonstrated as a prophylactic for organophosphate (OP) poisoning.

Organophosphates, including nerve gases such as Sarin, some insecticides, and some pesticides, have recently been used for acts of terrorism. The functional form of a ChE, a tetramer, is made by the T peptide at the C (carboxy)-terminus of the ChE gene. The T-peptide contains a proline-rich attachment domain (PRAD). PRADs of different proteins bind to tryptophan (W) amphiphilic tetramerization (WAT) domains at ChE C-termini. In the CNS, tetramers of ChE are embedded in the pre- and postsynaptic membranes in the brain via a proline-rich attachment domain (PRAD) of a proline-rich membrane anchor (PRiMA). Tetramers are anchored to the basal lamina of the neuromuscular junction (NMJ) via triple helical collagen Q (ColQ)'s PRAD, or exist as a free-floating soluble form in plasma. Preliminary data with one of the members of the MRL protein family, the Rap1-GTP-interacting adaptor molecule (RIAM), known to contain proline-rich regions similar to ColQ and PRiMA in its genomic structure, shows that expression of RIAM induces soluble tetramer formation. To further characterize the interaction between AChE and RIAM, we co-expressed nematode AChE (DvAChE) with truncated RIAM constructs. Our results indicate proline-rich domains of RIAM promote AChE tetramer formation.

Making Rational Decisions when Buying a House – Ask the Stock Market?

Mengsheng Cao and Jeffrey Barton

In this project we investigate the relationship between house prices and the performance of the stock market in China. We find the correlation between new house prices and the stock market index as well as between second-hand house prices and the stock market index. Based on available data we show that both new and second-hand house prices are positively correlated with the stock market and that second-hand house prices have the higher correlation. We further show that in the U.S. house prices are more strongly correlated with the stock market than in China. We examine the implications of these findings for decision making when considering the purchase of a house in China.

The effects of acetylcholinesterase and butyrylcholinesterase inhibitors on force of contraction, latent period, and tetanic fade of the gastrocnemius muscle in the Cane Toad, *Rhinella marinus*

Michael Cowan and Andrew Gannon

One of the fastest acting enzymes known, Acetylcholinesterase (AChE) hydrolyzes the neurotransmitter Acetylcholine (ACh) in the synaptic cleft between motor neurons and skeletal muscles. Acetylcholinesterase is necessary for terminating nerve stimulation at the end of a muscle contraction. The disruption of ACh binding to acetylcholine receptors (AChR) can lead to serious disorders such as myasthenia gravis (MG), a skeletal neuromuscular junction disorder that alters or blocks AChR's leading to muscle weakness. AChE has been linked to the regulation of the levels and activity of ACh in the neuromuscular junction (NMJ). AChE inhibitors, a treatment for MG, reduce hydrolysis of ACh which increases the levels and duration of action of ACh. Another enzyme, butyrylcholinesterase (BChE), has been shown to regulate ACh activity in the brain when AChE is absent. The force of contraction, latent period and tetanic fade was measured in *in situ* gastrocnemius muscle treated with specific AChE and BChE inhibitors. It was found that BChE acts as a secondary regulator of ACh in the neuromuscular junction as well. Inhibition of only AChE and inhibition of only BChE had no significant effect on force of contraction or latent period, but inhibition of both enzymes caused a 40.6% decrease in force of contraction ($p=.0049$) and 33.7% longer latent period ($p=.029$). These results add to the overall understanding of ACh regulation in the NMJ, and may contribute to future research to provide more effective treatment for myasthenia gravis and similar disorders.

Regulation of vacuolar size by *ypt4* and *lvs1*

Austin Culver and Melanie Styers

The mechanisms that regulate vacuolar homeostasis in fission yeast remain largely uncharacterized, but response to osmotic stress, regulation of vacuolar pH, and flow of membrane traffic have all been linked to maintenance of vacuolar size. We identified the fission yeast Rab4 ortholog *ypt4* as a mediator of vacuolar size. Staining with the fluorescent dye MDY64 revealed that deletion of *ypt4* or the *LYST* ortholog *lvs1* results in a significant increase in vacuolar size. *LYST* has been identified as the causative gene in the lysosomal biogenesis disorder Chediak-Higashi Syndrome and has been implicated in control of lysosomal fission. Challenging *ypt4* Δ or *lvs1* Δ cells with osmotic shock resulted in vacuolar fusion, similar to wild type (WT) cells, and delayed recovery suggested that increases in vacuolar size result from impaired fission. Endocytic traffic of FM4-64 to the vacuole was slightly decreased in *ypt4* Δ and *lvs1* Δ cells, but secretion was similar to that of WT cells. The *ypt4* Δ and *lvs1* Δ strains were sensitive to pH 7 media and media containing CaCl₂. Sensitivity may be due to changes in vacuolar pH, as quantification of Lysosensor DND-189 staining indicated that the vacuoles in *ypt4* Δ cells are more acidic. Importantly, overexpression of *lvs1p* rescued the vacuolar size defect present in *ypt4* Δ cells, but overexpression of *ypt4p* did not rescue *lvs1* Δ cells. Therefore, together, these results suggest that *ypt4p* is upstream of *lvs1p* in a pathway that regulates control of vacuolar size in fission yeast, providing insight into the function of orthologs of these proteins in human disease.

The Role of Pdr5 and Ipt1 in Resistance to Rhodamine 6G in *Saccharomyces cerevisiae*

Heather Daniel and Pamela Hanson

Drug resistance poses a threat when treating fungal infections in many individuals, especially those with compromised immune systems. Reduced intracellular drug accumulation is often a major contributor to drug resistance and can be established by membrane-associated drug efflux proteins, including Pdr5. Other factors such as plasma membrane lipid composition also influence drug resistance by restricting diffusion of toxins across the bilayer. Sterol and sphingolipid levels, in particular, seem to be critical in modulating passive movement of drugs across the plasma membrane. The enzyme Ipt1 synthesizes the complex sphingolipid, mannose-(inositol-phosphoryl)₂-ceramide [M(IP)₂C]. Although deletion of the *IPT1* gene was previously shown to increase resistance to some drugs, the mechanism behind this resistance remains unclear. In this project, we studied the effect of *IPT1* and *PDR5* deletion on resistance to rhodamine 6G. When comparing strains with and without *PDR5*, we confirmed Pdr5's role as a major regulator of rhodamine 6G resistance and intracellular drug accumulation. Specifically, yeast lacking Pdr5 were much more sensitive to rhodamine 6G and accumulated much higher levels of the drug. When characterizing *IPT1*'s role in rhodamine 6G resistance, we focused on strains lacking *PDR5* in order to avoid the potentially confounding effects of Pdr5's role in rhodamine export. We found that yeast lacking both *PDR5* and *IPT1* were more resistant to rhodamine 6G than yeast lacking only *PDR5*. This increase in drug resistance correlated with a reduction in intracellular rhodamine accumulation. Combined, these results suggest that membrane composition is an important contributor to yeast resistance to antifungal drugs.

The Geometric Series and Therapeutic Window

Adam Eiring, Ben Gaines, and Jeffrey Barton

We did our senior research in the field of pharmacokinetics, which is the study of how drugs move through the body including dissolution, absorption, and elimination. In this talk we examine a discrete, two-compartment model for an orally administered drug. We assume that the absorption and elimination are both first order processes. Our goal was to develop a formula to predict the maximum and minimum steady state drug levels in the blood based on a given drug dosage and frequency. We were able to successfully derive a formula for the minimum drug level in the blood. Our derivation makes extensive use of the geometric series formula.

Optimization and a Game of Thieves

Hope Ervin, Visvanathan Subramaniam, and Jeffrey Barton

The focus of this research is “The 0/1 Knapsack Problem” (KP), a combinatorial quandary in which one attempts to select items to fill a finite knapsack in a way that maximizes the total benefit of the items. Existent literature points towards three distinct techniques used to derive approximate solutions for the KP. These techniques are often referred to as the Greedy, Dynamic Programming, and Branch and Bound algorithms. Through this research, we attempt to identify the best approximation method for three distinct groups of thieves who, through mere coincidence, appear to rob the same museum at different points in time. Using this scenario, we want to identify which of the three approximation techniques would provide the optimum benefit for a given group in any position in the competition order.

Deletion of *IPT1* increases vacuole and cell size in the budding yeast, *Saccharomyces cerevisiae*

Michael Ferguson and Pamela Hanson

Sphingolipids play a significant role in membrane trafficking in the budding yeast *Saccharomyces cerevisiae*. For example, complex sphingolipids are involved in recruiting proteins that mark the site of and signal the initiation of endocytosis. Their importance is further emphasized by their function in organelle fragmentation. To synthesize complex sphingolipids, polar, sugar-containing head groups are added to ceramides, a simpler class of sphingolipid. In the final step of complex sphingolipid biosynthesis, the *IPT1* gene is required to add the last sugar to the head group of the complex sphingolipid, mannose-(inositol-phosphoryl)₂ ceramide (M(IP)₂C). Preliminary research suggested that vacuole size in *ipt1*Δ mutants was much larger in comparison to wild type cells, a result consistent with published high throughput studies showing that *ipt1*Δ yeast have defects in vacuole fragmentation. To better characterize these phenotypes, fluorescence microscopy and Image J software were utilized to quantify and compare vacuole size in wild-type and *ipt1*Δ mutant yeast stained with the fluorescent endocytic dye FM4-64. Our data showed that the vacuoles of *ipt1*Δ mutants were approximately 60% larger than those of wild type strains. Although cell size also increased in *ipt1*Δ mutants by approximately 22% , the vacuole-to-cell size ratio increased by approximately 28%, suggesting that the enlarged vacuoles in yeast lacking *IPT1* are not simply an artifact of cell size. These results provide substantial evidence that verifies and quantifies the effects of M(IP)₂C loss on vacuole size. Furthermore, these findings implicate complex sphingolipids as potential regulators of cell size.

A Look into the RSA Cryptosystem

Coleman Gorham, Robert Weaver, and Jeffrey Barton

Cryptology, the study of communicating with secret codes, influences many aspects of our daily lives, including ATM transactions and online credit card purchases. A problem in many cryptosystems is that of key transmission. If the encryption and decryption keys are the same, then before two individuals can exchange secret messages, one must send the other the key, and this introduces a security risk. If the key is intercepted, then all encrypted messages may be read. Our project examines the Rivest, Shamir, and Adleman (RSA) cryptosystem, which is a public-key encryption system. In a public-key system, the encryption and decryption keys are different. Anyone may encrypt a message to be sent to anyone else because each individual's encryption key is made public. However, only the intended recipient can decrypt a message because the decryption key is kept secret. Our research involves the history, evolution, and process of the RSA as well as a real world example to show our understanding of how the system works.

Habitat use overlap between an invasive crayfish, *Orconectes virilis*, and an endangered fish, *Etheostoma nuchale*

LaPrintence Gunn and R. Scot Duncan

A major cause for biodiversity loss in an ecosystem is the introduction of exotic species. Roebuck Spring, Alabama contains the largest of the five existing watercress darter, *Etheostoma nuchale*, populations. This habitat has been invaded by the northern crayfish, *Orconectes virilis*. Invasive crayfish can reduce fish populations through depredation, competition for food, and grazing on macrophytes and altering fish habitat. The impact on fish populations is dependent on the abundance, size, and possibly sex ratios of the crayfish population. We suspect the northern crayfish preys upon the darter and its eggs, and competes with it for food. Because both species seek out shelter in aquatic ecosystems, we are testing the hypothesis that *O. virilis* and *E. nuchale* share corresponding habitat preferences. Crayfish frequencies are being measured in the five most common habitats in the spring with unbaited minnow traps covered with black plastic to create a darkened interior attractive to crayfish. This novel trapping method avoids attracting crayfish from adjacent habitats. After 48 hours captured crayfish are sexed, measured and identified. The present study is being conducted during the spring 2015 and will help document the crayfish's habitat preferences during the darter's spawning season. We will compare our crayfish demographic data among habitats, and with our results from trapping in other seasons. By shedding light on whether the crayfish is a threat to the darter, our study may lead to interventions designed to help with the recovery of this endangered species.

The Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) in Central Alabama Pet Shops

Justin Haynes and Megan Gibbons

The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (Bd) is linked to the massive recent amphibian population declines and species extinctions observed across the globe in the past several decades. Bd causes chytridiomycosis, which is a fungal disease that can kill amphibian hosts by infecting their highly keratinized skin and disrupting ion exchange with their environment. While many species are affected by chytridiomycosis, other species are unaffected carriers who have helped to spread the disease. It is believed that the combination of environmental stressors, such as global warming and habitat loss have compounded the impact of the disease by making potential hosts more susceptible to infection or reducing their immune responses, making infections more deadly. Previous research has found several species of amphibians sold as pets carrying Bd, and at least some of these animals were originally imported from Asia to the United States. While Bd infections in the U.S. do not kill amphibians as rapidly as in other areas of the world, it is necessary to find out possible avenues through which Bd is brought into the country in order to document its location and work to prevent its further spread. The purpose of this project is to take skin swabs from amphibians in Central Alabama pet stores and test those swabs for the presence of Bd DNA by using polymerase chain reactions (PCR). Documenting the presence of Bd in local pet shops will help provide information on the role that the pet trade plays in spreading this disease.

The Effect of Blood Aging on the Formal Reduction Potential of Hemoglobin

Ben Hession and Scott Dorman

A problem faced by the medical world today deals with the donation and storage of human blood for transfusion. Blood shortages, blood storage techniques, and differences in fresh and old blood have led researchers to study the many facets of blood storage and transfusion more thoroughly. It is believed that because stored blood degrades over time, it has adverse effects on the body. We hypothesized that the formal reduction potential – or the inherent ability for a species to accept or donate electrons in an oxidation/reduction reaction – of hemoglobin in red blood cells will change over time, leading to adverse effects in the body when administered. Red blood cells (RBC) and supernatant (SN) solutions from 7-day-old and 35-day-old blood were analyzed using spectroelectrochemistry to determine the redox potential of heme iron in each solution. The average redox potential for 7-day-old RBC was -136.14 mV and the 7-day-old SN redox potential was -166.9 mV. The 35-day-old RBC redox potential was -132.64 mV and the 35-day-old redox potential was -172.5 mV. These values were much more negative than the published redox potential of -79mV, but the potentials for each solution did not change with respect to time.

Color, Depth, and Human Vision: Can we explain it?

Chase Hoffman and Duane H. Pontius

Human vision is an interesting physical conundrum that has been studied for years with no absolute explanation due to the complexities of the optical system. Many mathematical models have been proposed for human vision, but none have been able to explain all optical phenomena. Artists are well aware that different colors are perceived to be in different places though at the same position in space. The physical basis of this is chromostereopsis, or the perception of depth in two-dimensional images simply based on differing colors in the image. There are two components to this effect: longitudinal chromatic aberration, which is a separation of the image along the optical axis, and transverse chromatic aberration which is similar to the longitudinal effect but at some angle relative to the optical axis. In this paper, we produce a theoretical correlation for an image's position change relative to (1) a change in index of refraction and (2) a change in object distance. Using these two solutions, we compare apparent change in object location relative to the change in indexes of refraction to determine how pronounced this phenomenon is. Finally, we compare the longitudinal and transverse effects to determine which is more prevalent to vision.

Genetic engineering of lamellipodin-enhanced green fluorescent protein expression vectors: Effect on cholinesterase activity levels and tetramerization *in vitro*

William King and Leo Pezzementi

Soluble ChE tetramers in vertebrate sera were found to be associated with lamellipodin (Lpd) and other proline-rich cytoskeletal proteins. *In vitro* studies found an increase in ChE tetramer formation when ChEs were expressed with Lpd, with a related proline-rich protein, Rap1-GTP interacting adaptor molecule (RIAM), or with poly-L-proline. However, there was a decrease in ChE enzymatic activity levels in the presence of Lpd, which was not seen with RIAM or poly-L-proline. It was thought that the pEGFP plasmid that was used to express the Lpd-EGFP fusion protein was responsible for the decrease in ChE activity via the production of siRNA from the Neo/Kan cassette and from the EGFP. siRNAs are small interfering RNAs that inhibit translation of proteins. Previous studies involving subcloning of the Lpd-EGFP cassette from pEGFP into pcDNA3.1 ruled out the Neo/Kan cassette as the source of ChE down regulation, leaving the possibility of the EGFP as the source. Here, we present evidence that after successful EGFP excision, ChE activity remained downregulated by Lpd.

Scorpion Kaliotoxin Reverses Hyperkalemia, High Blood $[K^+]$, in Skeletal Muscle

Rohan Lal and Andy Gannon

Scorpion toxin causes symptoms such as nausea, muscle twitching, and tachycardia. Kaliotoxin, a scorpion toxin, inhibits voltage-gated and leak potassium channels, making cells less excitable. Hyperkalemia, high potassium concentration, $[K^+]$, in the blood, can be caused by acidosis and renal disease. Excess potassium ions increase cell excitability and allow an action potential to occur at a lower threshold voltage. To determine the effects of high $[K^+]$ and kaliotoxin, action potential thresholds were measured. Under hyperkalemic conditions, threshold voltage was reduced significantly ($p < 0.01$) from mean control values. When exposed to high $[K^+]$, muscle contraction force showed a significant increase ($p = 0.03$) from control, 1.60g (± 0.877 ; $n = 5$), to 2.56g (± 1.82 ; $n = 5$). High levels of K^+ had no significant effect on the latent period. The scorpion kaliotoxin decreased excitability in hyperkalemic cells – raising threshold voltage from a mean control value of 0.286V (± 0.298 ; $n = 10$) to 0.447V (± 0.431 ; $n = 10$). In the presence of kaliotoxin and hyperkalemic solution, muscle contraction force showed a significant increase ($p < 0.01$) from 2.07g (± 2.07 ; $n = 10$) to 7.82g (± 5.11 ; $n = 10$) and the latent period showed a significant decrease ($p = 0.28$) from a control value of 0.04s (± 0.04 ; $n = 10$) to 0.03 (± 0.03 ; $n = 10$). Hyperkalemic solutions decreased the threshold level significantly ($p < 0.01$) while scorpion kaliotoxin, diluted in hyperkalemic solution, allowed the threshold voltage to significantly surpass ($p < 0.01$) normal levels. Scorpion kaliotoxins reduced K^+ channel activation and can return cell excitability, under hyperkalemic conditions, to normal. Scorpion kaliotoxin is a potential treatment to reverse the effects of hyperkalemia.

Ultrafast Laser Pulse Shaping

Garrison Linn, David Hilton and Duane Pontius

Pump probe spectroscopy involves perturbing a substance with a highly energetic ultrafast laser pulse while simultaneously probing with a much less energetic pulse to determine the effects of the pump. This method has been highly successful at uncovering material properties, but it is limited because the pump delivers a single large jolt of energy to the system. There is interest in exploring the role of specific phonon modes (excited vibrational frequencies) in materials, which is difficult to do with a single excitation pulse. The purpose of this research is to construct a pulse-shaping device that can produce a series of ultrafast laser pulses spatially separated by tenths of picoseconds. To do so, we constructed a Fabry-Perot cavity to control the spatial separation of mirrors with extreme precision. The first part of this paper covers the analytic model for how an ultrafast laser pulse will propagate through the Fabry-Perot cavity, while the second covers the construction and testing of the actual device.

Anticancer ruthenium complex KP1019 induces Lcd1- and Swe1-independent filamentous differentiation in the budding yeast *Saccharomyces cerevisiae*

Anna Malles and Pamela Hanson

KP1019 is a promising new anticancer drug that induces apoptosis in cancer cells by causing DNA damage and oxidative stress. Because it activates the DNA-damage response pathway, KP1019 may be able to function as a differentiation therapy, a growing class of chemotherapeutics that fight cancer by triggering the reversion of dedifferentiated, neoplastic cells back to a more benign, specialized phenotype. *Saccharomyces cerevisiae* may serve as a useful model for eukaryotic differentiation. Under normal conditions, yeast cells divide in an undifferentiated, cancer-like state. However in response to nitrogen starvation, replication stress, or DNA damage, yeast can be triggered to undergo a process of specialization known as filamentous differentiation. The resulting changes in cell and colony morphology are activated by evolutionarily conserved genes. Specifically, the Mec1-DNA damage response pathway and the checkpoint kinases Lcd1 and Swe1 have been identified as key elements responsible for triggering filamentous differentiation in response to DNA-damaging agents like hydroxyurea (HU) and methyl methanesulfonate (MMS). In contrast to published work on HU and MMS, we did not find evidence that KP1019-induced filamentous differentiation in yeast is dependent on the proteins Lcd1 and Swe1. After treatment with KP1019, multiple trials revealed that Lcd1 and Swe1 showed a similar amount of filamentous growth as the wild-type. These results suggest that KP1019 may be triggering filamentous differentiation via a pathway distinct from that of other DNA damaging agents.

Exploration in Mechanical Design: Comparing SOLIDWORKS Finite Element Analysis with Strain Gage Measurement

Ava Louise May and Tyler Dart

The NASA Human Exploration Rover Challenge is an opportunity for designing, constructing and testing human powered mobile device technologies. High School and College teams design and construct human-powered mechanical moonbuggies to race through an obstacle course at the Space and Rocket Center in Huntsville, AL. We designed our moonbuggy in SOLIDWORKS, a computer-aided 3D design (CAD) software package, then built the moonbuggy. SOLIDWORKS can perform structural analysis of a mechanical body via Finite Element Analysis, a numerical mathematical model that treats the effects of external and internal forces. We analyzed the accuracy of Finite Element Analysis as a method for determining bending strain, which is the deformation that results from applying a load perpendicular to the longitudinal face of a slender structural element. We compared the results from the physical strain gauges attached to the aluminum moonbuggy frame with the results from the Finite Element Analysis.

The tetramerization of truncated hBChE co-expressed with Lpd, RIAM, MIG-10, and Poly-L-Proline

Jacob Mayfield and Leo Pezzementi

Organophosphate (OP) nerve gases and pesticides have been created to target the cholinergic nervous system, specifically cholinesterases, due to its importance in the animal kingdom. Two different types of ChEs are found in vertebrates, acetylcholinesterase (AChE) and butyrylcholinesterase (BChE). BChE's main role is protection against xenobiotics in serum, while AChE terminates signal transmission by hydrolyzing acetylcholine (ACh). Therefore, recombinant BChE has been proposed as a prophylaxis towards OPs. However, production problems have occurred due to the lack of formation of tetramers, the functional form of ChEs. Tetramers form via interactions between a tryptophan amphiphilic tetramerization (WAT) domain at the C-terminus of the catalytic subunit and proline-rich attachment domains (PRADs) of different proteins. *In vivo*, Proline-Rich Membrane Anchor (PRiMA) and collagen Q (ColQ) assemble tetramers in central synapses and neuromuscular junctions, respectively. It was recently discovered that various cytosolic proteins, including lamellipodin (Lpd) are associated with soluble ChE tetramers in serum. This study found that proline-rich fragments of MRL proteins, Lpd (lamellipodin) and RIAM (Rap1-GTP-interacting adapting molecule), caused an increase in tetramer formation, while the proline-deficient family member, MIG-10 (abnormal cell migration protein 10), did not. To investigate the role of the WAT domain in tetramer formation induced by proline-rich MRL proteins, we used the truncated clone, hBChE (G524_{STOP}), lacking the T-peptide containing the WAT domain. High velocity sedimentation gradients were used to measure the relative amounts of tetramer formed when hBChE (G524_{STOP}) was co-expressed with Lpd, RIAM, or MIG-10, and found that removal of the WAT domain prevented tetramer formation.

Determining if Dynamic Stretch, Strength, and Proprioceptive Exercises Reduce Rate and Severity of Injury in the Women's Soccer team at Birmingham-Southern College

Devin McDonald, Pete Van Zandt and Kyle Southall

The study of injury prevention in athletes is rapidly growing, with a great deal of focus on reducing lower extremity injuries of female athletes. Recent studies on the use of dynamic stretching in combination with strengthening and proprioceptive (balance) components in sport-specific warm-ups suggest that they are superior to traditional static and dynamic stretching techniques. The objective of this study is to determine if implementing a dynamic stretching routine with both strengthening and proprioceptive elements into a collegiate women's soccer team warm-up will decrease the number of exposures missed due to lower extremity injuries. An exposure comprises every organized, documented practice or game that each player participates in with coaches present. Specifically, this study will include a four-year cohort epidemiology approach by taking three years of preliminary injury data from the Birmingham-Southern College's women's soccer team and comparing them to an experimental fourth year of injury reports. This experimental fourth year differs from the three previous years due to the inclusion of a new warm-up intervention that consists of 20 new soccer-specific dynamic elements. While final data results are pending, observations thus far suggest that the new soccer-specific warm-up with the inclusion of strength and proprioceptive components did reduce the number of exposures missed during the experimental season; an ANOVA will be used to compare injury rates amongst the four years. A continuation of this protocol may be used to create an ideal soccer-specific warm-up to even further reduce lower extremity injuries in female soccer players.

Monitoring the hydroperiod and suitability for amphibian breeding at Oak Mountain State Park's vernal pool

Sydney Mclendon and Megan Gibbons

Regional changes in temperature or rainfall can alter a habitat such that necessary resources become scarce. Changes in habitat can lead to serious reductions in biodiversity, and even local extinction of species that rely on dwindling resources to complete their life cycles. Amphibians are greatly impacted by climate change because their reproductive physiology is sensitive to temperature and humidity. Many amphibians rely on vernal pools as breeding grounds. A vernal pool is a precipitation filled seasonal wetland that floods in the spring and dries as the summer progresses. For amphibians using the vernal pools for reproduction, breeding success correlates strongly with the vernal pools hydroperiod (the length of time that water is present in the pool, which varies in different environments and climates), but different species have different needs, in terms of timing and duration of the hydroperiod. At Oak Mountain State Park, the director of the Interpretive Center raised concerns when he anecdotally noticed that the hydroperiod of at one of the park's vernal pools seemed to be shorter than it had been historically. To gain further information about this site, BSC students have been monitoring the pool since 2012. I monitored the hydroperiod, pool demensions, and the timing of amphibian presence that used the pool for breeding during fall and spring 2014-2015. Long term monitoring of this pool might be necessary to determine if it can sustain the amphibian populations found in Oak Mountain State Park.

Interaction of the Antioxidant Glutathione with the Anticancer Ruthenium Complex KP1019

Sydney Middleton, Laura Stultz and Pamela Hanson

The search for novel anticancer drugs is ongoing, especially in light of the toxicity of current chemotherapies and emerging cancer cell drug-resistance. A promising new ruthenium anticancer complex is indazolium *trans*-[tetrachlorobis(1H-indazole)ruthenate(III)], or KP1019. KP1019 is considered to be a prodrug, meaning that the drug is activated by the reduction of its central ruthenium atom. An effect of this process is the production of oxidative stress, which could potentially be a method by which KP1019 damages cancer cells. As a result, reducing agents, like the antioxidant glutathione, could have effects on the activity of KP1019. Glutathione is the most abundant, naturally-occurring antioxidant in the body, and the compound is even more prevalent within cancer cells. Therefore, glutathione would likely interact with KP1019 by 1) possibly activating the drug with its reductive capabilities, 2) diminishing the cytotoxicity of KP1019 by alleviating the drug-induced oxidative stress, or 3) binding and altering the structure of the drug. This study investigated these potential interactions between KP1019 and glutathione by performing kinetics studies with UV-Vis spectroscopy, and examining changes in redox characteristics of the drug with cyclic voltammetry. The mechanism of this reaction has been found to be highly complex but does indicate significant, nuanced interactions between glutathione and KP1019.

Modeling the Population of the American Bison

Hunter Mims and Jeffrey Barton

The American bison (*Bison bison*) is an animal rich in utility that has been historically overexploited. The bison was regarded as sacred by many Plains Indian tribes, and in addition to being a major cultural and religious symbol, the bison was a major source of food for the tribes. In an effort to control the Native American population the U.S. government had the bison hunted to near extinction in the 1800's. Bison also play an important role in grassland ecosystems as their wallows and grazing activities provide nesting sites for many bird species and seed dispersal for many plant species. Thus it is important to monitor the population of American bison over time.

The goal of this project was to use a matrix model to make population projections for the American bison over time. Model parameters were determined from existing bison population studies. Using tools from linear algebra the stable age distribution of the population is predicted. Finally sensitivity analysis is performed on the model parameters to determine how changes in each parameter affect the projected stable distribution.

Correlation between linear enamel hypoplasia and cribra orbitalia in Native American populations of Alabama

Katie O'Bar and Jason Heaton

Examining patterns in skeletal pathologies is an indirect method of assessing a population's nutritional health. Two commonly studied nonspecific stress markers are linear enamel hypoplasia (LEH), a dental condition distinguished by the appearance of horizontal grooves of reduced enamel thickness, and cribra orbitalia (CO), the occurrence of macroscopic, protruding porosities on the orbital roof. Several etiologies have been proposed for LEH and CO, mostly centering on various nutritional deficiencies. To investigate the possibility of similar causes for both conditions, skeletal remains of Native Americans living at Koger's Island, Alabama ca. A.D. 1300-1450 were examined macroscopically for severity of LEH and occurrence of CO. It is hypothesized that if the causes for both conditions are the same, then individuals with severe LEH will be more likely to exhibit CO than individuals with mild or no LEH. Furthermore, because social status was central to this population, it is hypothesized that individuals of elite status will exhibit fewer occurrences of both conditions than individuals of nonelite status due to better diets. Regression analysis amongst these individuals evaluated any possible correlations between the two conditions and their association with social status, gender, and age. There does not appear to be any correlation between the conditions and their severity, but it was found that a significant amount of individuals age 20-40 displayed LEH, suggesting that generation may have experienced a nutritional deficiency during childhood, most likely around the time of weaning.

Comparison of respiratory sinus arrhythmia (RSA) magnitude in endurance and sprint athletes

Kathleen Pfitzer and Andrew Gannon

One of the most prominent effects of exercise programs on the heart is an increase in vagal tone- how much the parasympathetic nervous system decreases a person's resting heart rate via vagus nerve activity. One index of vagal control, Respiratory Sinus Arrhythmia (RSA), is the degree by which instantaneous heart rate is faster during inspiration than during expiration. A greater RSA has been found in athletes in some studies and is thought to indicate a high level of vagal tone and aerobic fitness. The aim of this study is to support the existence of RSA in athletes, and to compare RSA magnitude based on the type of training each athlete undergoes. In a comparison of college athletes, all athlete groups exhibited some degree of RSA. Although differences between categories of athletes were not statistically significant, as expected, endurance athletes showed the highest mean RSA, followed by those in the standard (athletes whose sports require endurance and sprint activities) and sprint categories, respectively. Overall, characterization of RSA in athletes is important in that RSA measurements can be a helpful tool in differentiating between cardiac conditions such as athletic and pathological cardiac hypertrophy.

Runx2 Regulates Osteoblast Signals that Control Spermatogenesis

Allison Pratt, Laura Stultz and Amjad Javed

Runx2 transcription factor is essential for development of osteoblasts, the fundamental cells responsible for the synthesis of extracellular matrix proteins necessary for bone formation. Global deletion of Runx2 gene in mice results in complete lack of bone formation. Interestingly, Runx2 deletion in mature osteoblasts results in poor osteoblast activity, failed post-natal bone acquisition, and pre-mature aging. The Runx2^{OB/OB} (mutant) mice also fail to reproduce, but the molecular reasons are unknown. In this study, histological, immunohistochemical, and biochemical approaches were used to assess testis development in 3-month-old wild type and Runx2^{OB/OB} mice. This analysis revealed that seminiferous tubules in the mutant testis are much smaller and poorly organized than in the WT, and the interstitial Leydig cells adjacent to the seminiferous tubules were not clearly identifiable in the Runx2^{OB/OB} testis. Immunohistochemistry revealed that multiple layers of spermatogenic lineage supporting cells were well organized from the basal lamina of each seminiferous tubule toward the lumen in the wild type testis, but these cells were disorganized and clumped near the basal lamina in the mutant. Mature sperm were almost entirely absent in the mutant testis. These results support that deletion of the Runx2 gene in mature osteoblasts impairs spermatogenesis and leads to male infertility.

Changes in Flight Phenology of Micromoths in Response to Birmingham's Urban Heat Island

Caroline Rowan and Peter Van Zandt

Warmer temperatures recorded in cities, as compared to surrounding rural areas, can be explained by the concept of an urban heat island. A number of characteristics of cities allow them to absorb more solar energy than rural areas. This energy is slowly released as heat into the lower atmosphere and can cause cities to experience warmer temperatures, particularly at night. The temperature differences that have been recorded in cities are comparable to the predicted increase in temperatures over the next century due to global climate change. Therefore, studying the effects of an urban heat island may be useful for predicting the effects of future global climate change and may provide valuable information that can be used to create conservation strategies. In this study, moth samples were collected at three locations that are varying distances from the center of Birmingham, Alabama (defined as urban, intermediate, and rural) to investigate whether moth phenology is advanced in the city due to the urban heat island effect. Samples were collected at each site using UV light traps twice a week from April to August, and the number of individuals of each focal species, *Arta olivalis*, *Arta statalis*, *Blepharomastix ranalis*, and *Lithacodes fasciola*, caught per site was recorded. Survival analysis was used to compare the flight phenology of the moths between the three sites. This is one of the first studies that examine the effects of an urban heat island on Lepidoptera and that compare moth phenology on a spatial, rather than temporal basis.

Application of studying commingled skeletal remains in the Birmingham-Southern College human skeletal collection

Carly Russell and Jason Heaton

This study examined the Birmingham-Southern College human skeletal collection to determine ancestry, age, and stature of the individuals within it. Methods used follow typical forensic anthropological procedures for working with commingled remains. A survey of the BSC human skeletal collection found that it consists of 209 identifiable skeletal elements, including long bones (e.g. femoral), flat bones, (e.g. crania), and short bones (e.g. carpals). Irregular bones were not included in this analysis. Based upon left tibiae, the minimum number of individuals (MNI) was determined to be eight. Using cranial and Os Coxal morphology, the collection contains at least three male and three female individuals. Using femoral, humeral and tibial measurements, stature estimates for this sample ranges from 139.8 cm to 172.0 cm. The age range for the sample is from 30 to 60 years. These age estimates were based on sutural or epiphyseal closure in the crania and long bones, respectively. And lastly based on cranial morphology, the collection contains individuals from Asian and European ancestry.

Predicted sex ratios of juvenile Kemp's ridleys (*Lepidochelys kempii*) in the northern Gulf of Mexico along the Mississippi coast

Catherine Sandon, Megan Gibbons and Thane Wibbels

The Kemp's ridley sea turtle is one of the most endangered sea turtles in the world. The population declined at an alarming rate between 1947 and 1990 due to incidental capture in fishing gear and egg collecting. Conservation efforts, such as reducing sea turtle bycatch and protecting nests, have initiated the recovery of Kemp's ridley sea turtles in the Gulf of Mexico and increased the number of nesting females at Rancho Nuevo, Mexico. Recent population studies on Kemp's ridleys suggest that these efforts have restored the species to a sustainable level. Sex ratios have significant impact on the reproductive output of a sea turtle population and are important reproductive parameters used by population ecologists and conservationists. There is a strong female biased sex ratio in every current Kemp's ridley population study in the northern Gulf of Mexico. In order to investigate the pervasiveness of this trend, the purpose of this study was to estimate the sex ratio of juvenile Kemp's ridleys collected from one foraging site on the Mississippi coast. The sex of juvenile Kemp's ridley turtles captured from this site in 2012-2013 was determined through radioimmunoassay (RIA) of plasma testosterone levels. Preliminary analysis suggests that our calculated sex ratio of the juvenile Kemp's ridleys on the Mississippi coast is consistent with those from previous studies in other regions of the Gulf of Mexico, which show substantial female bias. Of particular importance, the occurrence of a female biased sex ratio could enhance the recovery of the endangered sea turtle.

Construction of Astronomical Telescope: Newtonian Reflector

Pledger Schaefer, Kelsey Lindquist and Mark Rupright

In this project we researched the history, design, and construction of astronomical telescopes, with the overall goal of making one ourselves. After careful consideration of the pros/cons of different types of telescopes, we decided the best design was a Newtonian reflector telescope. Effort was made to do as much as possible ourselves. In particular, we chose to hand grind and polish the primary mirror and construct the telescope tube and mount ourselves. In some instances, machined precision necessitated the purchase of pre-made components. We will explain the construction of the telescope, discuss the assembly of components, and present the final product, its optical properties and defects.

Assessment of the Putative Encroachment of the Eastern Red Cedar, *Juniperus virginiana*, into the Kathy Stiles Freeland Bibb County Glade Preserve

Dylan Skipper and Peter Van Zandt

The Kathy Stiles Freeland Bibb County Glade Preserve (KSF) is a unique ecosystem claimed to be the most biodiverse habitat known in Alabama. These glades are home to rare floras that are tolerant of the thin magnesium rich soil which is otherwise toxic to plants. In general, the square footage of glade habitats has been on the decline since European settlement. Fire suppression among other items has contributed to the invasion of woody species. One species in particular, the eastern red cedar (*Juniperus virginiana*) is among the first to invade glade habitats. In fact, the presence of eastern red cedar is often used as a strong indicator of past ecological disturbances. This project aimed to determine whether the eastern red cedar is encroaching into the KSF glades. This assessment is important to understand in order to protect rare habitat specific flora of the KSF glades. A previous study showed that diameter at breast height (DBH) is highly correlated with tree age in the eastern red cedar in the KSF glades. Operating on this correlation, sixteen 10x5 meter transects were plotted at the tree line of four different glades in which DBH and distance into the tree line of eastern red cedars were measured. These measurements were analyzed to determine if a trend of red cedar encroachment existed. Aerial photos were also examined to provide insight on the historical boundaries of these glades. Preliminary results suggest the KSF glades tested do not display signs of encroachment by eastern red cedars.

Using Thermal Performance Curves to Assess the Potential Impact of Global Warming on *Spodoptera frugiperda*, the Fall Armyworm Moth

Kiera Stevenson and Peter Van Zandt

Urbanization is changing the phenology of many species by creating Urban Heat Islands (UHI), areas of cities that are warmer than surrounding habitats. UHIs should cause urban ectotherms to develop faster and be active earlier in the season than rural individuals, but this does not occur for all species. The explanation could be that urban habitats are at temperatures beyond some species' thermal optima, a point where the metabolism of ectotherms is fastest. The thermal optimum can be estimated using a thermal performance curve, which, when combined with biophysical models, can be used to predict the effects of climate change on a species' phenology. In this study, I employed an experimental setup using fish tanks instead of environmental chambers to allow me to estimate the thermal optimum of one species of moth, the fall armyworm (*Spodoptera frugiperda*). I chose this species because it had published estimates of its thermal optimum, which allowed me to validate my new methodology. I predicted that the larvae of the fall armyworm moth would show faster growth in higher temperatures due to its increased metabolic rate, but growth would be impeded at a point beyond the thermal optimum. After growing the caterpillars at ten different temperatures and measuring their growth, my method yielded qualitatively similar thermal optima results to those of published studies. Students will be now be able to use this setup to determine the thermal optima of other insect species at a fraction of the cost.

Development of a New Prostate Cancer Diagnosis: Synthesis of IVCrot

Jon Storey and David Schedler

Prostate cancer is the second most commonly diagnosed cancer in men over the age of forty, and the second leading cause of cancer-related death in America. The current methods of prostate cancer diagnosis have been found to be unreliable, and results in many false positives. This current research project investigates a potential new method of prostate cancer diagnosis. The enzyme α -methylacyl-CoA racemase, or AMACR, has been found to be up-regulated in prostate cancer tissues. This gives it promise as a prostate cancer indicator. If IVCROT does bind to AMACR, then it can be radioiodated and techniques such as PET scans can be used to determine whether AMACR is concentrated in the prostate. This could lead to much more effective prostate cancer diagnosis, especially if combined with current diagnosis techniques.

Meta-analysis of Hepatitis C Drugs

Rachael Tally and Peter Van Zandt

It is estimated that 3.2 million people have chronic Hepatitis C in the United States, and most infected are unaware. The Hepatitis C virus infection may be present for years and can lead to cirrhosis of the liver and liver cancer. For the past 25 years the protein interferon has been the drug of choice, due to its ability to interfere with viral reproduction. Interferon paired with ribavirin has brought those infected from a sustained virological response (SVR) of <5% to approximately 50%. The side effects from these drugs include but are not limited to inflammation of the pancreas, depression, anemia, and hair loss. A recent approach to chronic HCV is the triple therapy method. While this does include interferon and ribavirin, a multi-class combination of sofosbuvir, ledipasvir, and bocoprevir are included in the treatment. These can raise the SVR to 80-90%. The average cost for the treatment is upwards of \$100,000 per patient. The objective of the meta-analysis is to assess the SVR percentages of the combination drugs in comparison to current treatments.

An Assessment of Benthic Macroinvertebrates as Biological Indicators of Water Quality

Matthew Webster and Megan Gibbons

Alabama is home to a plethora of rivers, lakes, and streams that form a complex system of interconnected waterways throughout the interior of the state, and offer a variety of ecosystem services on which the human population in Alabama greatly depends. However, these indispensable aquatic resources are highly vulnerable to degradation as a result of pollution and other anthropogenic activities associated with a rapidly urbanizing society. To protect these precious resources, water quality monitoring efforts are of critical importance. Chemical and biological parameters are the most commonly used monitoring methods. However, recent studies suggest that the results of biomonitoring efforts do not necessarily match the expected results of water quality based on commonly used chemical water quality monitoring procedures. In this study, we compare the results of chemically-based water quality monitoring methods with the results of biologically-based water quality monitoring (biomonitoring) methods, in order to assess the relationship between chemical and biological parameters in water quality monitoring. In this study, we observe a variety of chemical/physical, and biological parameters, and using multivariate statistical analyses, we compare the biotic parameters with chemically-based water quality designations to better understand the relationship between chemically- and biologically-based indicators of water quality.

Potential Factors Affecting Men When Seeking Medical Help

William Weller and Jason Heaton

Recently, research has shown that men typically seek medical help less often than women. There are multiple hypotheses for why men choose to seek help less often. Potential reasons range from masculinity, a lack of time and knowledge, fear, or financial issues. Similarly, males of other species tend to hide their illnesses. By hiding their illnesses, males are capable of showing less weakness, which may potentially increase their chances for reproduction and survival. As a result, modern human behavior may be a reflection of evolutionary processes. A random sample of college students was given a questionnaire, which assessed variables such as masculinity and femininity along with how often the individuals sought help. After analysis, it was determined that there were differences in help seeking behavior between males and females ($p < 0.01$). Additionally, differences exist between how often individuals reporting to be sick in the past year and their masculinity/femininity scores ($p < 0.001$). Higher scores of masculinity were associated with lower levels of sickness, while higher scores in femininity were associated with illnesses that are more frequent (as reported). The results could give the medical community a greater understanding of patient behavior conceivably resulting in new approaches to the treatment of males. Time is a very important factor in the many medical conditions. Understanding the characteristics that men portray may help reduce the number of deaths resulting from late disease treatment.

An Introduction to Deterministic Chaos Within Physical Systems and Numerical Approaches to Fractal Dimension

Andrew Wisecarver and Mark Rupright

Analytical solutions to linear ordinary differential equation (ODE) systems are easily proven and widely anthologized. Nonlinear ODE systems, however, prove far more difficult to solve directly, and as such, numerical techniques are required to investigate. Nonlinear dynamics appear frequently throughout physics, from climate modeling to electrodynamics. Revived in the early 1960s, nonlinear science offers techniques for deciphering the mathematical symmetries latent in these problems, especially in understanding the nuances of deterministic chaos -- the wildly unpredictable but non-random behavior of strange attractors. I will present an overview of these topics, as well as an introduction to several established techniques for determining the topological dimension of these strange attractors within phase space. Specifically, I applied a computational technique known as the box-counting dimension to the Lorenz system, and I shall detail that approach here.