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Key of Categories & Table of Contents

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Please see the Program Update for additional poster presentations.

PR-01

Vitamin C Intake: Types of Food Consumed and Meal Pattern Differences in Children with High or Low Exposure to Environmental Tobacco Smoke.

AM Preston, L Vazquez Quinones, CM Perez, E Perez Torres, C Rodriguez.

Department of Biochemistry, Univ Puerto Rico, Medical Sciences Campus, San Juan, PR.

Vitamin C is an antioxidant of major importance. Ample evidence exists for the detrimental effect of environmental tobacco smoke (ETS) on vitamin C status in exposed populations, however there is no information on meal pattern differences in vitamin C intake between populations either exposed or not exposed to ETS. We assessed consumption of foods containing from zero to high amounts of vitamin C and determined contribution of regular meals and snacks to the daily intake of vitamin C in children with either high (HEX) or low (LEX) exposure to ETS. The study group contained 508 healthy children aged 2 to 13 years routinely visiting a clinic. Dietary intake of vitamin C was obtained with a 24 hr recall questionnaire. Smoke exposure was assessed by measuring urinary cotinine. Children were divided into HEX and LEX groups according to the mean value of cotinine. Both groups of children consumed amounts well in excess of the RDA recommendations for vitamin C but children with LEX had a significantly higher mean daily intake (123.4 mg) than HEX children (102.4 mg). Meal patterns showed that breakfast provided the greatest percent of daily vitamin C for both groups (31% for LEX, 36% for HEX). No differences were noted between groups in the percent of daily intake of vitamin C consumed at lunch or dinner (21% and 23% for LEX and 25% and 25% for HEX respectively). The major difference in percent of daily intake as well as amount of intake was in snacks. Children with LEX consumed about 26% of their daily vitamin C by consuming snacks with high amounts of vitamin C while HEX children consumed only 15% of their daily vitamin C by consuming snacks with low amounts of vitamin C. Furthermore, the morning snack was the major contributor in explaining the difference. Supported by NRI of USDA, CSREES grant no. 94-37200-0602.

PR-02

Nanotechnology and Photochemistry in Photomedicine

Dr. Luis A Rivera Montalvo,

University of Puerto Rico, Mayaguez Campus, Department of Chemistry

The presentation will describe my trajectory from photochemistry and nanoparticle studies to biomedical applications in photomedicine, with emphasis in photodynamic therapy. Different projects will be described and general results presented in this trajectory, which is characterized by interdisciplinary research. Areas covered include organic chemistry, bioinorganic chemistry, photochemistry, photophysics, nanotechnology, materials science, photophysics and photomedicine. Examples of projects involving these areas will be described.

PR-03

Pharmaco-EEG: A Study of Individualized Medicine in Clinical Practice

Ronald J. Swatzyna (The Tarnow Center for Self-Management, Houston, Texas), Gerald P. Kozlowski (Saybrook University), Jonika Tannous (Rice University, Houston), Christine Schieszler (The University of Houston), Vijayan Pillai (The University of Texas at Arlington)

The recent introduction of the Research Domain Criteria (RDoC) project is an initiative by the National Institute of Mental Health (NIMH) to develop innovative ways of identifying and classifying mental disorders through discovery of neurobiological features that underlie observable behaviors. The NIMH is discouraging researchers from simply collecting symptoms based on DSM categories. One of the objectives in our clinical practice has been to collect electroencephalography (EEG) and quantitative EEG (qEEG) data. In the past five years, we have identified a subset of refractory cases (n=386) found to contain commonalities of a small number of electrophysiological features in the following diagnostic categories: mood, anxiety, autistic spectrum, and attention deficit disorders, Four abnormalities were noted in the majority of medication failure cases and these abnormalities did not appear to significantly align with their diagnoses. Those were: encephalopathy, focal slowing, beta spindles, and transient discharges. To analyze the relationship noted, they were tested for association with the assigned diagnoses. Fisher's Exact Test and Binary Logistics Regression found very little (6%) association between particular EEG/qEEG abnormalities, i.e. neurobiomarkers and diagnoses. These findings suggest that EEG/qEEG may give additional information to understand pharmacotherapy failures.

PR-04

Temperature-sensitive sorting to lysosome-related organelles.

Alexander C. Theos

Department of Human Science, Georgetown University

Loss of function mutations in mammalian tyrosinase, an integral membrane protein required for the melanin biosynthesis within the mammalian melanosome, result in oculocutaneous albinism. The Himalayan allele of mouse tyrosinase is a temperature-sensitive mutant that has been previously shown by others to be restricted to the ER at the non-permissive temperature but sort efficiently to the melanosome at the permissive lower temperature. We have developed novel tools to further elucidate temperature-dependent tyrosinase misfolding, ER exit and subsequent trafficking to the melanosome. Through molecular biology techniques chimeric proteins were engineered with both wildtype mouse tyrosinase and Himalayan proteins fused to EGFP or mRFP. The steady-state intracellular localization of these fluorescent proteins was tested by transient expression in non-pigmented and melanocytic cells as well as stable expression after retroviral infection. The temperature-dependent sorting of these proteins to lysosome-related organelles was analyzed through cyclohexamide and endoglycosidase-H treatments and subsequent western blotting as well as immunofluorescence microscopy. As shown previously for untagged tyrosinases, the temperature-sensitive tyrosinase-EGFP was unable to exit the ER at the non-permissive temperature. At the permissive temperature, the constructs were able to sort to the lysosome in non-pigmented COS-7 cells, and the mature melanosome in human melanoma cells. Biochemical experiments involving inhibition of new protein synthesis with temperature shift suggest that block to ER exit of the Himalayan protein synthesized at the restrictive temperature may be reversed at the permissive temperature. Our newly developed fluorescent constructs are an effective tool for studying the biosynthetic transport of cargo to lysosome-related organelles.

PR-05

Nanomechanical Properties of Breast Cancer Microtissues

Jorge I. Rodríguez-Dévora, Aesha Desai, Nasim Nosoudi, Delphine Dean, Department of Bioengineering, Clemson University

The biomechanical properties of cancer cells have been identified as a potential cue to distinguished metastatic tumorous cells from their healthy counterparts. The goal of this study is to understand how culturing conditions affect these properties during culturing of breast cancer tumor-like microtissues. Breast cancer (MCF-7) cells were culture by the hanging-drop technique to allow them to conform in spherical microtissues. The experiment used two culture regimens, the first using standard media and the second supplementing it with methylcellulose (MC), known in these cultures for improving its compactness and sphericity. Samples were collected up to 15 days to study their morphology, proliferation, and strength. Proliferation assays confirmed that cells continue to replicate after ten days of culturing. Moreover, the ability to form a spherical shape was greatly improved by MC. The maximum strength was observed by day 3 and had a steady decrease upon time. The strength results suggest that while MC increases the ability of cells to conform into spherical shapes it does not improve the stiffness of cells significantly. This study increases our understanding on the degree of manipulation of in vitro tissues, supporting the aim to create a more relevant in vitro cancer model for an improved anticancer drug screening.

PR-06

Origin of the Twist in Crystalline Cellulose

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Department of Chemistry, McGill University

Abstract Molecular Mechanics, Hartree-Fock, and Semi-Empirical geometry optimizations were carried out on cellulose oligomers with and without water solvation. The intramolecular bonding is visualized with the Delocalized Molecular Orbitals (DLMOs). Internal coordinates were relaxed and the structures were gradient optimized for cellulose composed of 10, 12, 14, 19, and 65 glucose units. The cellulose conformation of minimum energy deviates from the at ribbon conformation giving rise to repeating units of 3.9 nm and 60 nm along the chain axis. An optimized cellulose chain which is ten glucose units long is 9.57 kcal/mol more stable than the at ribbon model. The DLMOs show the twisted model retains the same hydrogen bonding scheme as the at model while minimizing steric- interactions between H1 and H4'.

PR-07

In the Canopy with Tardigrades and Wheelchairs

William R. Miller

Our 2013-2014 REU was a collaborative research project that investigated the hypothesis of uniformity in the density, diversity, and distribution of the little known animals of the phylum Tardigrada in the canopy of Kansas. We learned and used double rope climbing technique to ascend into the unexplored canopy of the oak-hickory deciduous forest on the edge of the tall grass prairie. In the field over two summers, we have climbed up to 20 meters (65 feet) into 252 trees representing 19 species. We collected 1396 samples from two different habitats (mosses & lichens) at four different levels above the ground. In the lab, we extracted 12,318 tardigrades of 20 species of which four are new to science. We have rejected the hypothesis of uniformity by discovering tardigrades to be significantly more common in the upper reaches of the canopy than at lower levels. We uncovered positive and negative relationships among species of tardigrade, habitats, substrates (tree species) and locations. Differential Interference Contrast (DIC) and Scanning Electron (SEM) microscopes were used to observe and measure the internal and external characteristics necessary to identify tardigrades. We have presented our results to the biology faculty of Baker University, the science staff at the North Carolina Museum of Natural Sciences and the California Academy of Sciences. Our students have presented at Sigma Xi, CUR, and Kansas Academy of Science meetings. We conducted public outreach with "Water Bear Hunts" at the Overland Park Arboretum. Our team included students with ambulatory disabilities who climbed into the canopy from their wheelchairs. We have hosted a student with Tourette's Syndrome and a Navy Veteran. We have published 8 papers and have four manuscripts under review. Many of our students are pursuing independent tardigrade research projects at their home schools.

PR-08

The Pendulum and Three Standards That Measured the Ancient World

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We will show how a simple pendulum can be used to create a uniform, easily replicable system of measurement and how the Ancient Mesopotamians in the third millennium BCE developed standards of measurement which are entirely consistent with one based on the length of a one-second pendulum.

Just as the metric system would establish similar length-based standards 5000 years later, the Sumerians used the length of this pendulum to create all their standards of length, distance, volume, and weight. It appears that the Egyptians improved on the accuracy of this concept by using the stars to time their pendulum. Later the Minoans on Crete would use the planet Venus when in opposition as their clock.

These three concepts spread throughout the Ancient world from Britain in the West to China and Japan in the East. Examples of the first standard can be found in China, and in France as well as in Mesopotamia. Examples of the second can be found in Phoenicia and early Rome, as well as in Egypt. Examples of the third can be found not only on Crete but in Okinawa Japan, and in medieval England where they are immortalized in the Magna Carta of 1215. The old saying "a pint a pound the world around" had been true for over 3000 years.

Later cultures would mix and match these three standards resulting in a confusion of methods of measurement which obscured the magnificent achievements of these civilizations from so long ago.

PR-09

Exploring the substrate range of wild-type and evolved aminoacyl-tRNA synthetases

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We tested the substrate range of four wild-type Escherichia coli aminoacyl-tRNA synthetases (AARSs) and evolved Methanosarcina mazei pyrrolysyl-tRNA synthetases (PylRSs) with a library of non-standard amino acids (nsAAs). While the AARSs can discriminate efficiently against the other canonical amino acids, they were able to use many nsAAs as substrates. Genetic selection provided PylRS variants with a broad range of specificity for diverse ncAAs. Our results also indicated that E. coli tryptophanyl-tRNA synthetase (TrpRS) and tyrosyl-tRNA synthetase have overlapping substrate range. In addition, we found that the anticodon sequence of the tRNATrp isoacceptor altered the substrate range of TrpRS; this implies that the sequence of the anticodon affects the TrpRS amino acid binding pocket. These results highlight again that inherent AARS polyspecificity will be a major challenge to the goal of incorporating multiple different amino acids site-specifically into proteins.

PR-10

Hobbies Among Early Sigma Xi Members

George Edw. Seymour, San Diego Chapter

In 1936 Henry Baldwin Ward and Edward Ellery, honoring the founding and early history of Sigma Xi, published a twelve hundred page tome titled, "Sigma xi half century record and history, 1886-1936," which to this day serves as a prime historical document of the Society. It identified each Chapter in chronological order as well as all of the members and associates in alphabetical order. Equally interesting was the inclusion of a twenty-four page listing of member hobbies. That hobby listing and those hobbies serve as the focus of this report which seeks to understand the types of hobbies appreciated most by scientists and engineers back then. The membership mentioned a total of 379 different hobbies, a surprising number given that many current options for hobbies were not available back then. The sheer magnitude of the entire hobby list is difficult to contemplate, and certainly those early Sigma Xi scientists and engineers were an eclectic assemblage.

BSS-01

Invalid Neurocognitive Baseline Testing in High School Athletes Using the ImPACT® Test Battery

Grant Iverson (Harvard Medical School, Spaulding Rehabilitation Hospital, and Mass General Hospital), Margie Rayford (Harvard Medical School)

Introduction: In the United States, the annual incidence of sports-related concussion is estimated to be more than 300,000. Baseline neurocognitive preseason testing is now a common part of concussion management programs. Presently, limited research has been conducted on invalid baseline neurocognitive test scores using ImPACT®.The characteristics of those athletes who have invalid test scores are poorly understood. We hypothesized that high school athletes with attention deficit hyperactivity disorder (ADHD) and/or a learning disorder are more likely to obtain an invalid test score when compared to athletes without these disorders.

Methods: During the years 2009-2012, 33,732 high school athletes from Maine participated in baseline neurocognitive testing using the Immediate Post-Concussion Assessment and Cognitive Testing ImPACT® battery. ImPACT® is a computerized neurocognitive screening battery that is widely used for baseline testing and for post-injury evaluations following sport-related concussions. Athletes with valid versus invalid scores were compared.

Results: In the total sample (N=33,732), 6.4% of the student athletes had invalid neurocognitive test scores using ImPACT®. When compared to those with valid scores, student athletes with invalid ImPACT® scores were more likely to report a history of (i) receiving speech therapy (201 (8.6%)), (ii) diagnosis of a learning disability (193(15.3%)), (iii)diagnosis of ADHD (225 (10.3%)), (iv) repeating ≥1 year of school, (v) treatment for headache (274 (8.3%)), (vi) treatment for migraine (199 (8.3%)), (vii) treatment for epilepsy/seizures (37 (11.0%)), treatment for substance/alcohol abuse (21 (13%)), and treatment for a psychiatric condition (172 (8.2%)).

Conclusion: Athletes with a learning disorder and/or ADHD have a greater rate of invalid baseline neurcognitive test scores when using the ImPACT® test battery.

Key Terms: Baseline Testing
ImPACT Test Battery
Neurocognitive

BSS-02

Genetic and Social Factors Influence Allostatic Load in American Samoans

Gwendolyn Donley (The Ohio State University), Advisor: Dr. Douglas Crews (The Ohio State University)

Biological stress responses across physiological systems may lead to an accumulating allostatic load (AL). AL represents erosion from a peak physiological state through homeostatic conservation. Genetic, social, and environmental factors influence AL and may contribute to noncommunicable disease vulnerability and morbidity. Previous studies demonstrate associations of age, sex, and education with AL. Therefore, we examine relationships of these factors along with alleles at the apolipoproteins (apos) E and H, atrial natriuretic peptide (ANP), and angiotensin converting enzyme (ACE) loci with AL in a sample of 273 American Samoans. We assessed AL using three combinations of biomarkers (secondary mediators of allostasis and insulin, body habitus, and metabolic). Values in the highest risk quartile were assigned a score of 1. Regression indicated that ANP, apo H, and education are not closely associated with AL. However, men and individuals carrying the apo E 3,2 or ACE I-D genotype had lower overall AL (p<.05). Participants aged 55 and over with the apo E 3,2 genotype and those under age 55 with the ACE I-D genotype also had lower AL. Effects of education varied across the three AL constructs. Genetic predictors of physiological dysfunction are important mediators of risks for morbidity, senescent biology, and mortality across populations. This is the first study to confirm a significant relationship between genotypes and AL within a Polynesian sample. It also demonstrates that age and sex modulate genotypic association with AL.

Key Terms: Biological Anthropology
Genetics
Stress

BSS-03

Oh the lemons in life: Individual differences in emotion processing predict post trauma depression

Tabitha N. Alverio (University of North Carolina at Charlotte) Dr. Sara M. Levens (University of North Carolina at Charlotte)

The effect that trauma has on a person is variable—some individuals may develop depression, stress, or post-traumatic stress disorder, while others will cope more adaptively. A plethora of research has examined the negative effect of trauma on behavior and cognition. Yet less research has been conducted to elucidate what cognitive processes may underlie whether a person develops depression or is resilient after a stressful event. The objective of the present study is to investigate whether emotion-processing differences in working memory may underlie the development of depression and stress (or not) in response to experiencing trauma. Participants completed a two part study. In Time 1 (T1) participants completed an emotion N-back task and questionnaires assessing trauma history and current depression and stress symptoms. At Time 2 (T2; approximately 3 months later) participants completed depression and stress questionnaires. Participants were grouped at Time 1 according to whether they had experienced a trauma (Trauma group) or had not experienced a trauma (No-trauma group) in the last 6 months. N-back task performance was compared between the Trauma and No-trauma group. In addition correlation analysis were conducted to determine whether engaging and disengaging from emotional content in the emotion n-back task predicted later levels of depression and stress in the trauma group. Results reveal that of the individuals who experienced a recent trauma updated fearful and sad stimuli slower than individuals who had not experienced a recent trauma. In addition, rapidly disengaging from positive content at T1 predicted higher levels of depression symptoms at T2. These findings suggest that difficulty keeping positive information active may predict development of depression symptoms. Furthermore these findings suggest that assessments of individual differences in emotion processing may be predictive of post trauma experiences, thoughts, and behaviors.

Key Terms: Depression
Emotion Processing
Working Memory

BSS-04

Use of Electric Field Sensors for Continuous, Noncontact Recordings of Rodent Behavioral and Physiological Variables

Camden MacDowell (Emory University), Michael McKinnon (Emory University), Don Noble (Emory University), Tamra Noblest (Emory University), Mallika Hader (Emory University), Bill Goolsby (Emory University), Advisor: Shawn Hochman (Emory University)

Behavioral neuroscience studies rely heavily upon the accurate quantification of animal behavior and internal physiological state. However, these parameters can vary significantly depending on confounding factors in the laboratory environment including: (i) stress exposure associated with transport/handling, (ii) surgical interventions, and (iii) the testing environment. Recording physiological and behavioral variables in a home-cage environment without experimenter intervention is desirable, but current systems for automated home-cage recordings of these variables are expensive and/or require devices that are surgically implanted or chronically affixed to the animal.

To assess behavioral and physiological measures non-invasively and without human interaction, we tested whether a newly available electric field sensing chip (EPIC chips; Plessey Semiconductors) could serve as an inexpensive, non-contact method to record respiratory rate, heart rate, and motor behaviors continuously in the home-cage of Sprague-Dawley rats. EPIC chips were affixed to the exterior of the cage or placed within PVC tubing shelters. Movement-related voltage changes were observed during periods of gross motor activity. Characteristic voltage oscillations were also seen during more subtle repetitive motor movements such as respiration, cardiac contraction, sniffing, grooming, and whisking, as verified with simultaneous video recordings. Additional experiments comparing the EPIC chips to simultaneous electrocardiogram and plethysmography chamber recordings confirmed accuracy in the measured heart and respiratory rates.

We have begun developing data recording methods for continuous remote monitoring of rodent behavior in the vivarium home-cage environment for upwards of 24 hours to test whether this approach can be used to more completely characterize behavioral phenotype of individual animals.

Key Terms: Behavioral Neuroscience
Research Tool Development
Engineering

BSS-05

The Underrepresentation of Women and Recommendations for Increasing Multicultural Diversity in STEM Syllabi

Michael Savaria (University of Massachusetts Dartmouth), Kristina Monteiro (University of Rhode Island), Advisor: Ricardo Rosa (University of Massachusetts Dartmouth).

Despite various national initiatives, women are among the most underrepresented groups in science, technology, engineering, and mathematics (STEM) undergraduate majors of higher education, which contributes to low numbers of women occupying STEM careers. Several pedagogical recommendations have been developed to reduce stereotype threat, a barrier preventing women from excelling in this domain, such as encouraging optimistic faculty student relationships, promoting multicultural engagement (i.e., affirming and accepting one's identity within the stereotyped groups), and placing value on multiple perspectives. The syllabus, a document distributed to students during a time of open enrollment, provides key insights into the future of the course. A critical discourse analysis of two introductory engineering course syllabi at a large 4-year public university revealed that there were limited to no inclusion of (1) course-level student learning outcomes, (2) background information to assist in identifying with the instructor, (3) connections to majors and topics outside of engineering, (4) encouragement of interactions (e.g., faculty-student or peer relationships; teamwork), (5) personal growth and societal impacts of engineers, or (6) acknowledgement of underrepresented groups in STEM fields. These syllabi do not include the necessary pedagogical techniques to increase engagement for underrepresented groups to remain in the course, complete the curriculum, or encompass feelings of success in the field. The alteration of course syllabi to address the unique needs of underrepresented groups may help to reduce the gender gap, promote the increased involvement of women in STEM fields, and lead to advancements in science and establishing social justice.

Key Terms: STEM
              Multiculturalism
              Student Engagement

BSS-06

Vital Improvements to the Youth Risk Behavior Survey: A Logical Approach

Bryan Nelson (New York University), Advisor: Aimee Nelson (Duke University)

In Massachusetts, the Youth Risk Behavior Survey is administered every other year in randomly selected public high schools. In order to examine its effectiveness, students in the Hamilton-Wenham School District were tested for self-esteem levels, surveyed on dietary and exercise tendencies, completed a short-term memory test, and filled out a brief meal log. Participants showed a strong association between self-esteem and strictness of their diet as well as a strong association between the percentage of calories eaten from carbohydrates and short-term memory. In women, there were strong negative associations between self-esteem and exercise frequency and between the percentage of calories from sugar and short-term memory. Further, in men, there was a strong negative correlation between the percentage of calories from fat and short-term memory as well as a strong positive correlation between the percentage of calories from protein and short-term memory. Lastly, there was a statistically significant difference between the amount of sleep students in the Hamilton-Wenham School District get and what doctors recommend. There is now evidence that the Massachusetts Youth Risk Behavior Survey should also be testing to ensure that students are sleeping adequately, eating properly, and should more accurately assess their self-esteem.

Key Terms: Public Health
              Self-Esteem
              Psychology

BSS-07

The analysis of Iranian EFL learners' acquisition of the American, British and Australian accents

Ramin Pouriran (Shahid Beheshti University of Medical Sciences), Khashayar Pouriran (Shahid Beheshti University of Medical Sciences) Advisor: Dr. Samad Sajjadi (Shahid Beheshti University of Medical Sciences)

Persian and English are both Indo-European languages with similarities in their roots. As such this experiment was conducted to understand which English accent (i.e. American, British or Australian accents) would be easier for Iranians to adapt. To answer this question, 30 medical students performed three different activities of (a) listening to audio texts in three accents, (b) taking part in an oral interview and (c) completing an attitude questionnaire. The activities examined comprehensibility of the accents that the participants were subjected to, type of accent that they themselves produced and their attitude toward the accents under study.

As for the audio texts, the order of presenting the three accents to the subjects was counterbalanced in order to control the order effect. The data on audio materials were analyzed for comprehensibility, accentedness, intelligibility and acceptability. Regarding comprehensibility, American accent was the most comprehensible (85%). Considering accentedness, intelligibility and acceptability, the partici-

pants found American accent the least accented (70%), the most intelligible 80% and the most acceptable (95%).

In the interviews, students' accents were closer to the American accent. 85% of the participants used American accent in their conversational exchanges. Those with British and Australian accents formed 10% and 5% percents respectively.

Regarding attitude, also, the participants mostly (90%) preferred American accent over the British or Australian accents.

Iranian students' tendency to adapt American accent more openly is mainly rooted in a mentality that American accent is the most prestigious and easiest for the brain to digest.

Key Terms: Iranian adaptability toward American accent
             Acquiring American accent
             Iranian perceiving American accent

ists in the colony were short-term specialists foraging in runs for one food source or the other. Finally, workers varied significantly in lifetime foraging effort; in particular, a small cohort of individuals accounted for most of the sucrose collected.

Key Terms: Radio Frequency Identification
             Foraging Behavior
             Reward Specialization

BSS-08

Bringing Big Data To Small Bees: Patterns Of Reward Specialization

Avery Russell (University of Arizona), Sarah Morrison (University of Arizona), Advisor: Daniel Papaj (University of Arizona)

For many pollinator species, pollen and floral nectar constitute important and complementary nutrient sources. Although the majority of flowering plants offer both types of rewards, most studies of pollinator behavior have focused on nectar use. Studies examining how individual pollinators allocate foraging effort to pollen versus nectar are rare; even rarer are studies of reward specialization within colonies of social insect pollinators. The eusocial Eastern Bumble Bee (Bombus impatiens) provides an excellent system for studying nectar and pollen foraging patterns at the level of both individual worker and entire colony. To obtain a complete description of reward specialization for all foragers in the colony, we used a radio frequency identification (RFID) system in which all 100+ foragers were fitted with 2mg Microsensys mic3 transponders. Using first-of-its-kind automated data processing software, we gathered a complete record of visits to pollen and 'nectar' (in the form of sucrose solution) by all foragers in the colony. The distribution of individual foraging specialization over the lifetime of a colony was unimodal, ranging from extreme pollen specialization to extreme sucrose specialization, but with most individuals collecting substantial amounts of both nutrients. The colony-level pattern of generalized reward use was biased toward collection of sucrose. Moreover, most of the long-term reward general-

CBB-01

The in vitro Evaluation of Pediatric Brain Cancer Cell Lines

Charles Phillips (Tougaloo College), Advisor: Scharri Walker (Tougaloo College).

Brain malignancies are the most common form of solid tumors found in children. Treatment for these malignant growths typically requires a combination of surgery, radiation therapy, and chemotherapy. Chemotherapy specifically can have undesired toxic effects. Cabazitaxel was recently approved for the second line treatment of hormone refractory prostate cancer. This compound possesses the ability to pass through the blood brain barrier making it a promising chemotherapy agent for brain malignancies. However, to date, no studies have been conducted investigating the efficacy of this compound in pediatric brain tumors. To address this problem, we designed a series of studies to determine the anticancer efficacy of cabazitaxel in medulloblastoma (D341Med) and fibroblast (IMR-90) cell lines. Standard cell culture techniques were used to establish the D341Med suspension cell and the IMR-90 adherent fibroblast cell lines. D341Med cells exhibited a spherical structure with growth occurring in clusters; whereas, the IMR-90 fibroblasts grew with an elongated bipolar/multipolar structure. The aim of future in vitro mechanistic studies will be to determine the anticancer potency of cabazitaxel and to establish the underlying mechanisms of action for any observed anticancer activity. The effects of this compound are to be tested by, but not limited to, a cytotoxicity assay, a proliferation assay, an assay for apoptosis, and finally a cell cycle assay. These findings will further establish the rationale of cabazitaxel as a chemotherapeutic agent in the pediatric population.

Key Terms: Cancer Studies
             Pediatric Brain Cells
             Chemotherapy Research

CBB-02

The Effects of Synthetic Stilbenes on Metastasis Associated Protein 1 (MTA1) Levels In Prostate Cancer Cells

Diva Whalen (Tougaloo College), Benjamin Bates (University of Mississippi Medical School) Advisor: Dr. Anait Levenson (University of Mississippi Medical School)

Earlier findings discovered in Dr. Levenson's laboratory have shown that Resveratrol and Pterostilbene have an inhibiting effect on the tumor progression metastasis associated protein 1 (MTA1). Resveratrol and Pterostilbene (PTER) are natural compounds found in red wine and blueberries. These compounds are able to inhibit tumor progression by reducing the amount of MTA1 produced by the prostate cancer cells. This discovery is important; yet, because of low bioavailability and quick metabolism in the body, Resveratrol does not remain available long enough to effectively reduced in MTA1 levels. On the other hand, PTER has a higher bioavailability because of its molecular structure. Thus, this study was designed to analyze the potency and effectiveness of PTER's derivatives against the protein MTA1. By treating the most aggressive prostate cancer cell line, prostate cancer bone metastasis 3 (PC3M) in 5, 25, and 50 μM concentrations, we hoped to not only see a reduction in cancer cells which could translate into a reduction in MTA1 but also a stronger potency in lower concentration ($<50\mu M/mL$) which means a smaller amount of the compound could be administered. The preliminary western blot screenings of the synthetic derivatives showed promise for many of the twenty derivatives tested. In future studies, we hope to study the effectiveness of the best derivatives in a mice model that represent an aggressive form of prostate cancer.

Key Terms: Prostate Cancer
             Western Blot
             Tumor

CBB-03

Multilayered Peptide-based Biocomposites for Potential Bone Tissue Regeneration Applications

Steven M. Romanelli (Fordham University), Karl R. Fath (City University of New York Queens College), Aruna P. Phekoo (City University of New York Queens College), Advisor: Ipsita A. Banerjee (Fordham University)

Multilayered, biocompatible, biodegradable scaffolds for tissue engineering (TE) have gained popularity in recent years. In this work we have developed a new family of biocomposite scaffolds for bone tissue regeneration utilizing the layer-by-layer (LbL) assembly approach. We synthesized fluorenylmethyloxycarbonyl (Fmoc) protected valine conjugated with cetyl amine. The conjugate that formed was found to self-assemble into nanofibrillar assemblies which we utilized as templates for developing scaffolds by LbL assembly. The templates were first functionalized with Type I collagen as a primary layer followed by a hydroxyapatite binding peptide sequence derived from dentin sialophosphoprotein and the osteoinductive bone morphogenetic protein-4. The nanoassemblies were then bound to hydroxyapatite nanocrystals doped with varying mass percentages of titanium dioxide (TiO2) nanoparticles. Finally in order to develop multilayered three-dimensional scaffolds, we coated the nanocomposites with alginate. The morphologies of the nanoassemblies were examined by transmission electron microscopy and scanning electron microscopy and the binding interactions were studied by Fourier transform infrared spectroscopy. The assemblies were determined to be biocompatible and adhered to mouse preosteoblast MC3T3-E1 cells and promoted osteogenic differentiation as indicated by alkaline phosphatase

assay results. Additionally the nanoassemblies exhibited biodegradability and possessed antibacterial capabilities. Thus we have developed a new class of biocomposites with potential application in bone tissue regeneration.

Key Terms: Hydroxyapatite
Bone Regeneration
Tissue Engineering

CBB-04

Elucidating which Epstein-Barr Viral miRNAs Target Human Apoptotic Genes

Jennifer So (Rollins College), Diana Cox (Rollins College), Daifei Liu (Yale University), Advisor: Kasandra J. Riley (Rollins College)

Epstein-Barr virus (EBV) was the first identified oncovirus and can induce lymphoproliferative diseases including Burkitt's lymphoma (BL) and nasopharyngeal carcinoma (NPC). MicroRNAs, a recently discovered class of minute, non-coding RNAs, regulate cellular processes by binding to and repressing the translation of specific messenger RNA targets. EBV was the first virus identified to have microR-NAs and expresses 49 mature miRNAs. Published data from high-throughput biochemical studies in Jijoye BL cells reflected that human apoptotic genes contain potential EBV miRNA binding sites. This study aims to specify which and to what extent EBV miRNAs target human transcripts involved in apoptosis or altruistic cell suicide. Studies utilizing luciferase assays demonstrated that EBV miRNAs down-regulate both an inhibitor of apoptosis and a pro-apoptotic gene. In one case, a viral miRNA had bound to a human transcript via at least three binding sites, each of which contributed to the total repression of the reporter. Generally, EBV miRNAs with more extensive base pairing or multiple target sites repress target mRNAs more robustly. These findings suggest that EBV miRNAs target both pro- and anti-apoptotic transcripts.

Key Terms: Epstein-Barr virus
Burkitt's lymphoma
miRNA

CBB-05

MAZ Regulation of G-quadruplex Structures in the kRAS Promoter

Ashley King (Tougaloo College), Jennifer Hockings (The University of Mississippi), Advisor: Tracy Brooks (The University of Mississippi).

kRAS belongs to the RAS protein family of GTPases that functions to signal cell growth, differentiation, and organ development. When mutated, kRAS signals the nucleus mitose continuously. Previous studies have shown that a G-quadruplex (G4) DNA structure can regulate the tran-scriptional activity of kRAS. Literature suggests that G4 structures form from G-rich regions of DNA closest to the transcriptional start site; however, our studies oppose this and highlight further G-rich regions (termed mid and far) to form silencing G4 structures. In addition, the MAZ transcription factor has been shown to activate kRAS transcription, and it's suggested that this activation comes from interactions with the near-G4-forming region. A mapping of MAZ binding sites confirms that one exists in the near region and two exist in the mid-region. Our current studies thus concentrated on where MAZ-induced transcriptional activation of kRAS expression occurs. Using a series of luciferase plasmids harboring various regions of the kRAS promoter, either transfected alone into HEK-293 cells or with a MAZ-expression vector, we studied the role of MAZ in kRAS transcription. After confirming MAZ protein was expressed through a Coomassie stained protein gel, we confirmed that adding the mid+far regions of the kRAS promoter increased transcription by >15%, but deleting the near region from the whole promoter decreased transcription by almost 30%. Thus the findings indicate that the transcription of kRAS is more complicated than expected and more studies into other regions of the promoter, or into other proteins, such as Sp1, p53, or WT1, are required.

Key Terms: Cellular Biology
Pharmacology
Biomolecular Sciences

CBB-06

Cellular reprogramming during cutaneous wound healing

Arijh Elzein (University of California, Irvine), Christian Guerrero-Juarez (University of California, Irvine), Advisor: Maksim Plikus (University of California, Irvine)

In contrast to embryonic skin, adult mouse skin loses many of its regenerative properties. Unlike embryonic skin wounds, adult skin wounds typically heal with scars. Recently this paradigm has been challenged. Following large wounding, skin in several mammals, including mice, can regenerate new, complex tissue structures, most prominently hair follicles. New hair follicles spontaneously form in the large wounds' center. These new follicles display normal morphology and resemble hair follicles in unwounded skin. This phenomenon of *de novo* hair follicles regeneration suggests that adult cells in large wounds can display an unusually profound degree of lineage plasticity.

We wanted to investigate the degree of cellular plasticity displayed by wounds. We hypothesize that once formed, *de novo* hair follicles can alter the signaling profile in wounds and, potentially drive the surrounding cells toward alternative cellular fates.

We employ several wound-specific Cre-based lineage tracing tools to faithfully label various progenitor cell populations and trace lineages to which they contribute. We characterized tamoxifen-inducible wound-specific Cre line that allows spatial and temporal control over cell labeling and tracing.

We observe that large wounds can regenerate other skin-specific cell types, beyond the hair follicle. Furthermore, we found that *de novo* hair follicles are required to stimulate these additional regenerative events. We conclude that adult mouse wounds are able to create embryonic-like conditions, allowing for more robust cellular reprogramming to occur. My ongoing studies on this topic are focused on delineating the signaling interactions between hair follicles and other wound cell types that enable reprogramming phenomenon.

Key Terms: Wounds
                      Skin regeneration
                      Hair follicles

CBB-07

Regulation Of Regeneration In Mouse Ear Hair Follicles

Melisa Fuentes (University of California, Irvine), Advisors: Ji Won Oh (University of California, Irvine), Maksim Plikus (Universityof California, Irvine)

The hair follicle is a dynamic mini-organ that regenerates cyclically. The hair cycle consists of growth (anagen), regression (catagen), and rest (telogen). In mice, telogen consists of two sub-phases: competent telogen, in which the regenerative response is induced, and refractory telogen, in which the regenerative response is inhibited. In humans, scalp hair follicles affected by androgenetic alopecia enter an extended phase of telogen and become arrested in a refractory-like state. Currently, no mouse models for androgenetic alopecia exist. The objective of this study is to characterize hair cycle regulation in rarely cycling mouse ear hair follicles, and to determine if the mouse ear can serve as a potential model for studying the mechanism of extended androgenetic alopecia-like telogen. Plucking was determined as an efficient method in inducing hair follicle regeneration. Hair follicles were plucked in isolated locations of the ear to establish the presence of regional specificity. EdU, a (5-ethynyl-2'-deoxyuridine) nucleotide analog that marks actively proliferating cells, was administered to mice before ear collection. EdUstaining was used to identify actively regenerating hair follicles. Heat maps of hair follicle growth enabled standardized comparison between experimental groups. Non-stimulated, spontaneous ear hair follicle regeneration was characterized similarly. Whole ear plucking induced a wave of hair follicle regeneration. Plucking of 200 hairs resulted in faster hair regeneration in some ear regions than others. Spontaneous hair regeneration was observed in more responsive regions. Future research will aim to determine the signaling basis of the extended ear telogen and the regional differences of hair regeneration.

Key Terms: Hair Follicles
                      Hair Cycle
                      Regeneration

CBB-08

Ligand Discovery from a Crystal Structure and Homology Models of Sodium-glucose Co-transporters

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The sodium-dependent glucose co-transporters (SGLTs) are membrane proteins that function by harnessing the energy stored in transmembrane sodium gradients to actively transport sugars, which are crucial for maintaining cellular energy homeostasis. In humans, dietary glucose is imported via SGLT1 (hSGLT1) in the small intestines, while hSGLT2 reabsorbs filtered glucose in the kidneys. Diabetic patients suffer from improper sugar handling that results

in dangerously high levels of plasma glucose, and it has been proposed that reduction of blood glucose levels in type 2 diabetics could be achieved through inhibiting SGLTs. Unfortunately, hSGLT1 inhibition leads to severe diarrhea and dehydration due to osmotic imbalance in the intestines. However, inhibition of hSGLT2 has minimal side effects making it a promising drug target. The recent crystal structure of the bacterial homolog of hSGLTs, vSGLT, has made it possible to rationally pursue drug discovery efforts. Here, we use computational methods to identify high affinity ligands for vSGLT, hSGLT1, and hSGLT2. We created homology models of hSGLT1 and hSGLT2 based on the vSGLT structure and then carried out structure-based in silico inhibitor screens against all three transporters. Over 9.5 million compounds were screened from 7 libraries in the Zinc database, and we present the top candidates for each membrane protein along with their predicted poses. Since our ultimate goal is to target hSGLT2 and not hSGLT1, we focus on those compounds with maximal differentiation. Additionally, we report high affinity hits against vSGLT, which have the potential to aid in crystallizing the transporter in new conformations.

Key Terms: Sugar Transport
                     Homology Modeling
                     Computational Drug Design
                     Pharmaceutical Chemistry

CBB-09

The role of Wnt/β-catenin signaling in blood-brain barrier repair in EAE

Sigal Kofman (University of California, Irvine), Advisors: Justin Lengfeld (University of California, Irvine), Dr. Dritan Agalliu (University of California, Irvine)

Blood-brain barrier (BBB) breakdown is a significant factor leading to the progression of Multiple sclerosis (MS). We have shown that the Wnt/β-catenin pathway, necessary for BBB development, is upregulated in Experimental Autoimmune Encephalomyelitis (EAE), a mouse model for human MS. These findings suggest that Wnt/β-catenin pathway may repair the damaged BBB during disease remission. The objective of this study is to evaluate the efficacy and dosage of the Wnt-pathway activator compound, 6-Bromoindirubin-3'-oxime (BIO) as a therapeutic agent to repair the damaged BBB in EAE mice. TCF/LEF-GFP::H2B (Wnt reporter) mice, which express nuclear GFP in cells where the Wnt/β-catenin pathway is activated, were treated with BIO at 2mg/kg or 10mg/kg for ten days. Control mice received DMSO at 10mg/kg. Afterwards, spinal cords were collected, sectioned at $12\mu m$ and stained for nuclear GFP and Glut-1, a brain endothelial cell (BEC) marker. We imaged and quantified GFP intensity in blood vessel nuclei in spinal cords. We found that BIO treatment at 2mg/kg did not significantly change nuclear GFP compared to control treatment. However, BIO treatment at 10mg/kg increased by 14% the fraction of eGFP-positive BEC nuclei compared to controls. Therefore, treatment with BIO at

10mg/kg or higher doses is required to upregulate Wnt-pathway in TCF/LEF GFP reporter mice. In future studies we will repeat BIO treatment at 10mg/kg or higher doses and assess the fraction of GFP-positive in blood vessel nuclei. We will also treat EAE mice with BIO to analyze the effects of increased Wnt/β-catenin signaling on disease progression and BBB function.

Key Terms: Blood-brain barrier
                     Multiple Sclerosis
                     Experimental Autoimmune
                        Encephalomyelitis

CBB-10

The Genetic Basis for Elevated Platelet and Tissue Plasminogen Activator Inhibitor-1 in the LEWES/EiJ Mouse Strain

Stephanie Verbeek (Oakland University), Amy E. Siebert (Oakland University) Advisor: Dr. Randal J. Westrick.

The fibrinolytic system is essential for normal vascular function and defects in this system contribute to several thrombotic disease states. Plasminogen Activator Inhibitor-1 (PAI-1) is a serine protease inhibitor that crucially inhibits fibrinolysis and is produced primarily by platelets and endothelium. Since increased PAI-1 levels have been associated with thrombotic disease in humans, we used mouse models to investigate both PAI-1 antigen and transcript level in whole liver and platelets. We identified LEWES/EiJ and C57BL/6J mouse strain differences in expression (RT-qPCR) and antigen (ELISA) PAI-1 levels in liver and platelets. In whole liver, we found a significant difference between Serpine1 (PAI-1 gene) expression in C57BL/6J and LEWES/EiJ ($p < 0.005$) but no difference in whole liver PAI-1 antigen levels. Striking differences in PAI-1 antigen levels were observed in the platelets; C57BL/6J had 1.8 pg/million platelets, while the LEWES/EiJ strain had robust platelet PAI-1 production with 62.5 pg/million platelets ($p < 0.04$). Crossbreeding experiments produced F1 mice with average platelet PAI-1 levels of 55 pg/million platelets. The differences in protein levels suggest a semidominant genetic effect regulating PAI-1 between these two mouse strains. A genome scan of 27 F2 mice using 419 markers revealed 2 candidate loci, independent of the PAI-1 locus, on chromosomes 2 and 13. Further mice are being generated to confirm these findings and fine map the genetic interval. The identification of a gene regulating PAI-1 expression will provide insight into platelet specific gene expression as well as providing a novel therapeutic target for modulating thrombotic disease.

Key Terms: Hematology
                     Genetics

CBB-11

Identification of Thrombosis Modifier Genes in ENU Mutagenized Mice

Marisa Brake (Oakland University), Amy E. Siebert (Oakland University), Advisor: Randal J. Westrick (Oakland University)

A variant of coagulation Factor V called Factor V Leiden (FVL) is the most common known genetic risk factor for venous thrombosis (VT). However, FVL displays incomplete penetrance as only about 10% of FVL carriers develop VT. The objective of this study is to understand the genetic components influencing the penetrance of the FVL phenotype. We identified a perinatal lethal phenotype in homozygous FVL mice also heterozygous deficient for tissue factor pathway inhibitor ($FV^{Q/Q} TFPI^{+/-}$). We then used a genome wide ENU mutagenesis screen to identify modifier genes rescuing the $FV^{Q/Q} TFPI^{+/-}$ mice by ENU mutagenizing $FV^{Q/Q+} TFPI^{+/-}$ males then breeding them to $FV^{Q/Q}$ females. Any surviving $FV^{Q/Q} TFPI^{+/-}$ offspring have acquired an ENU induced gene mutation that suppresses the lethal $FV^{Q/Q} TFPI^{+/-}$ genotype. These viable offspring were mated back to $FV^{Q/Q}$ to create 15 thrombosis suppressor lines. In order to identify the suppressor gene mutations in one of the lines, five mice from a line were whole exome sequenced and 251 potential candidate mutations were identified. To determine the actual suppressor mutation among the candidates, a cohort of mice were genotyped for the presence of each mutation by PCR followed by Sanger sequencing. Thus far, 14 candidates have been sequenced. Kaplan-Meier survival curves of each putative modifier were insignificant. The remaining candidate suppressor mutations are being sequenced. Whole genome sequencing of mice from the remaining lines is in process. The identification of thrombosis modifier genes will provide insight into the pathways leading to thrombosis and facilitate novel therapeutic interventions.

Key Terms: Genetics
                    Blood Coagulation
                    Mutagenesis

CBB-12

Discovery of a novel polypeptide ligand targeting α6β4 expressing pancreatic adenocarcinoma cells

Karthik Raju (Mira Loma High School), Ruiwu Liu (UC Davis), Sidhartha Hazari (UC Davis), Kit Lam (UC Davis)

Pancreatic adenocarcinoma is the deadliest form of cancer with a five-year survival rate of only 3%. A key to this devastating, highly invasive disease is the difficulty involved in its detection at an early stage. Recently, the α6β4 integrin, an adhesive laminin receptor, has been reported to over express as a biomarker in pancreatic cancer due to differential gene regulation. Furthermore, it is also thought to play integral roles in pancreatic tumor motility and invasion. Clearly, α6β4 is a potential target for the detection and targeting of pancreatic cancer cells. The aim of this project was to construct a peptide ligand to effectively and specifically target the α6β4 integrin. Three "One-bead one-compound" (OBOC) cyclic combinatorial libraries were designed based on the eGk motif, synthesized, and screened against α6β4 expressing cells. Positive ligands were further screened in vitro with various pancreatic cancer cell lines. The initial screening results were corroborated by establishing α6β4 expression levels. A novel cyclic peptide, LLR7, with high binding specificity to α6β4, was identified. The identified peptide holds the promise of serving as a non-invasive binding agent that will effectively aid in tumor imaging. Once conjugated to different chemotherapeutic nano particle carriers, LLR7 can also serve as an early prognosis, irrespective of the stage and development of the pancreatic cancer.

Key Terms: Combinatorial Biochemistry
                    One-bead-one-compound
                    pancreatic cancer

CBB-13

Characterization of a cotH deleted mutant in Bacillus pseudoalcaliphilus

Ethan Rath (North Central College) and Dr. Nancy Peterson (North Central College)

The bacteria *Bacillus* form a complex protein spore coat that allows it to resist many stressful environments. This spore coat has the potential to act as a model for the formation of other complex protein structures, including the formation of ribosomes. In both B. *anthracis* and B. *subtilis*, the *cotH* gene has been shown to be important in exospore and outer spore formation. In order to determine the importance of *cotH* in a different species, a *cotH* deleted strain of *B. Pseudoalcaliphilus* was created. These mutants showed decreased resistance to high temperatures as well as lysozyme activity. There was also a decreased germination from spores to vegetative cells. The gathered data produces new implications in the importance of cotH in spore coat formation.

Key Terms: Bacteria
                    Complex Protein Structure
                    Mutation

CBB-14

Genetic Characterization of Tetracycline Resistant Aeromonads From the Rock River and Wastewater Effluent in Rockford, Illinois

Sarah Kobernat (Rockford University, Rockford, Il, Knox College, Galesburg, Il), Sarah Stringer (Rockford University), and Advisor: Troy Skwor (Rockford University, Rockford, Il and University of Illinois at Rockford, Rockford, IL)

Ubiquitous to aquatic environments, Gram-negative *Aeromona*s bacteria are known fish and human pathogens, often associated with wound and gastrointestinal diseases. Therefore, antibiotic resistance within *Aeromonas* is a serious concern and the source of contamination needs to be identified. The purpose of this study was to optimize and execute a multiplex PCR to determine the presence of five different tetracycline resistant genes (*tetA – tetE*) from tetracycline resistant Aeromonads isolated from the Rock River, in Rockford, Illinois and post-chlorinated effluent from human wastewater. Optimization was performed on dNTP concentration, reaction volume, Taq polymerases, template DNA concentration, and annealing temperatures associated with the PCR amplification. After ideal conditions were determined, DNA was isolated from tetracycline resistant bacteria and subjected to multiplexing PCR to amplify the presence of tet genes. Each amplicon size for the five genes differed in size so it could be differentiated on a 1.2% agarose gel. Our findings have identified *tetA* and *tetE* as the most prevalent amongst both river and post-chlorinated samples. Genetic characterization of tetracycline resistance within the *Aeromonas* population is important because it provides a molecular profile thus aiding in identifying a contaminating source for the resistance as well as suggesting genes responsible for the resistant phenotype.

CBB-15

Characterizing Cell Cycle Errors Associated With Loss Of Cul3

Brittney Davidge (Portland State University) and Jeffrey D. Singer (Portland State University)

Regulation of the eukaryotic cell cycle is a complex process and involves the coordination of many molecular mechanisms. Cell cycle defects are associated with pathogenic conditions including cancer. The cell cycle is separated into three stages: G1 when the cell has not begun DNA replication, S phase (DNA synthesis), and G2/M which includes cells that have completed S phase and are preparing to divide. Cells that are not dividing have exited the cell cycle and are in a stage called G0 or quiescence. Ubiquitin-mediated proteolysis of cell cycle regulatory proteins is necessary for proper cell cycle control and involves attachment of ubiquitin to the target protein. This attachment requires an E3 ubiquitin ligase to recognize the substrate and facilitate ubiquitination. The cell cycle regulator cyclin E is ubiquitinated by the E3 ligase Cul3. We are working to determine the mechanism by which this ligase functions to signal cyclin E degradation. Based on data from our lab we hypothesized that Cul3 degrades cyclin E in quiescence to maintain that state. To test this hypothesis we are using mouse embryonic fibroblasts (MEFs) that contain an engineered allele of Cul3 that allows us to delete the Cul3 gene at will in living cells.

Additionally, Cul3 uses an adaptor protein called RhoBTB3 to recognize cyclin E and mediate its destruction. Here we show that the N-terminal region of cyclin E is required for binding both Cul3 and RhoBTB3. Using additional cyclin E mutants, we hope to further identify the residues involved in these interactions.

Key Term: Cell Biology

CBB-16

Identification and Characterization of Actr2 as a Major Thrombosis Modifier Gene in the Mouse

Amy E Siebert (Oakland University), Stephanie Verbeek (Oakland University), Marisa Brake (Oakland University), Guojing Zhu (University of Michigan), Kart Tomberg (University of Michigan), Advisor: Randal Westrick (Oakland University)

Factor V Leiden (FvL) is the most common inherited risk factor for venous thrombosis, however, not all FvL carriers develop the disease. In order to identify potential FvL modifier genes, a sensitized dominant ENU mutagenesis screen was performed based on the perinatal synthetic lethal thrombosis observed in mice homozygous for FvL ($Fv^{Q/Q}$) and hemizygous for tissue factor pathway inhibitor deficiency ($Tfpi^{+/-}$). Whole exome sequencing and variant analysis revealed 11 high confidence novel heterozygous (dominant) single nucleotide variants (SNVs). Sanger re-sequencing of all 11 SNVs in a cohort of mice identified a mutation in the *Actr2* gene (present in 15/16 re-sequenced progeny p<0.0001) as a genetic suppressor in the lethal prothrombotic FvL mouse model. The *Actr2* gene encodes the Arp2 protein, which is essential for modifying the intracellular actin network. Complete blood counts (Advia 2120) performed on 14 *Actr2* heterozygous and 10 wildtype littermates revealed no significant differences in platelet count, red and white blood cell counts, hematocrit or hemoglobin. However, three measurements of platelet size were significantly altered in Actr2 heterozygous mutant mice (p<0.05 for each measure). Thus, partial deficiency of Arp2 appears to alter platelet structure/function resulting in a shift in hemostatic balance facilitating survival of the otherwise lethal $Fv^{Q/Q}$ $Tfpi^{+/-}$ phenotype. Results from these studies may aid in understanding potential relationships between variations in *Actr2* and the modification of thrombosis risk in humans, and possibly also identify novel therapeutic targets for disruption of hypercoagulable states.

Key Terms: Genetics
             Blood Coagulation
             Mutagenesis

CBB-17

The mouse equivalent to the human cell therapy Ixmyelocel-T allows for analysis of mechanistic activity in an immunocompetent animal model of critical limb ischemia

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Ixmyelocel-T (Ix-T) is a human cell therapy shown in phase 2 trials to be safe and significantly prolong time to treat-ment failure in patients with critical limb ischemia (CLI). The cells responsible for Ix-T function are mesenchymal stem cells (MSCs) and M2 macrophages, implicating an immune response in Ix-T activity. To understand the mechanisms by which Ix-T functions, a mouse equivalent of Ix-T (mIx-T) was developed to allow testing in immunocompetent animal models of CLI. We demonstrate that mIx-T contains functional MSCs and M2 macrophages and that transplantation of mIx-T into a mouse model of CLI significantly increases blood flow and reduces levels of necrosis in affected hindlimbs. The use of mIx-T will allow us to mechanistically understand how Ix-T enhances therapeutic outcomes in patients with CLI as well as identify the processes that prevent blood flow recovery and ultimately induce necrosis and tissue loss in CLI.

Key Terms: Stem Cell Therapy
             Critical Limb Ischemia

CBB-18

The Impact of Norrin on the Structural Integrity of the Ischemic Retina

Erin Feeney (Oakland University), Kevin Roumayah (Oakland University), Wendy Dailey (Oakland University), Dr. Kimberly Drenser (Oakland University)

Retinopathy of Prematurity (ROP) is a pediatric retinal disease afflicting approximately 10% of babies born prematurely, accompanied by the risk of retinal detachment, blindness, and life-long implications for vision health. Ina an animal model of ROP, exposure to high oxygen levels after birth induces severe disruption in retinal layer organization; furthermore, subsequent removal from the hyperoxic environment leads to vaso-obliteration and development of pathologic blood vessels, termed neovascularization. Our research seeks to develop a drug therapy that will improve the retinal function of ROP patients by limiting the area of ischemic tissue and restoring the integrity of cellular organization within the layers of the retina. Previous studies have shown that Norrin, an endogenous protein that acts as a ligand in the Wnt-Signaling Pathway, reduces the overall avascular area in the ROP model retinal tissue. We hypothesized that it also has the capacity to exhibit a neuroprotective effect on ROP retinas. Through the use of the Oxygen-Induced Retinopathy (OIR) Model, which mimics the conditions of the ROP retina in mice, we sought to quantify this effect by performing an intra-ocular injection of the compound Norrin in vaso-obliterated mice. Our results showed an increased quantity of observable Retinal Ganglion Cells (RGCs) in the central portion of the retina of Norrin-treated mice compared to mice injected with a vehicle control. We conclude that treatment with Norrin does exhibit a neuroprotective effect on the retina. Our future studies will seek to examine Norrin's role as a ligand for alternative receptors in the Wnt-Signaling Pathway.

Key Terms: Pediatric Retinal Disease
             Translational Research

CBB-19

Photodynamic Therapy Using Metalloporphyrins Kill Cancer Cells Via Reactive Oxygen Species

Abby Menke (Rockford University), Advisor: Matthew Bork (Rockford University), Troy Skwor (Rockford University)

Metalloporphyrins are cyclic compounds that contain a central metal and show characteristically strong selective wavelength absorption. Photodynamic therapy (PDT) utilizes three key components: a photosensitizer (the metalloporphyrin), visible light (LEDs), and oxygen to create reactive oxygen species (ROS). Cancers have been treated with PDT and may serve as a safer alternative application. The main objective of this experiment was to test the oncolytic ability of different metalloporphyrins (MP-105, MP-106 and MP-107) on cancerous cervical epithelial cells (HeLa) through PDT. HeLa cells were cultured in 6-well plates at 1×10^5 cells/mL and treated with the metalloporphyrins in the presence of 405nm light emitting diodes (LEDs) 24 hours after plating. To determine if ROS were involved in oncolytic activities, reduced glutathione was added as well. A MTT assay was used to analyze cell viability 24h after treatment. All metalloporphyrins (MP105, MP106, and MP107) with PDT decreased cell numbers when compared to control groups. The efficiency of the PDT varied depending on the metalloporphyrin being used and the dosage of 405nm LEDs with MP106 demonstrating the most oncolytic effect with 405nm. These effects were reversed in the presence of reduced glutathione demonstrating ROS dependency. Our findings support the potential use of metalloporphyrins with PDT as a method for cancer treatment. PDT offers an alternative treatment with the benefits of safer application and fewer side effects than the current treatments though more clinical applications need to be performed.

Key Terms: Photodynamic Therapy
Oncolysis
Biology

CBB-20

Strong Bacteriocidal Effect Against Staphylococcus aureus from Photodynnamic Therapy with Metalloporphyrins

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Escherichia coli are Gram-negative, facultative anaerobic bacteria, which are found living in the digestive tract of humans and animals. Pathogenic species of E. coli can cause serious gastrointestinal and urinary tract illnesses. Gram positive *Staphylococcus aureus* are common etiologic agents of skin, soft tissues, lower respiratory tract, and bloodstream diseases. Both of these bacteria have acquired multi-drug resistance, making them increasingly difficult to treat. The Centers for Disease Control and Prevention (CDC) reports that in 2013, approximately 2,049,442 illnesses and 23,000 deaths were caused by bacterial infections that showed resistance to antibiotics. We are interested in finding a new alternative treatment clinically which would eliminate the use of antibiotics. Our study aimed at eliminating bacterial growth through photodynamic therapy (PDT) involving metalloporphyrins and 405nm LEDs. Bacterial cultures were incubated with different types of metalloporphyrins and exposed to 405 nm LED lights (WARP, Quantum Devices) at different energy levels (J/cm2). Additionally, reduced glutathione was added to determine if bacteriocidal effects were due to reactive oxygen intermediates. Bacterial counts for each treatment were determined and PDT with our metalloporphyrins lysed both Gram-positive and negative bacteria, with a significantly more bacteriocidal effect on Gram-positive *S. aureus*. Knowing this, we also studied the effects of ampicillin with PDT to determine if antibiotics would work in a cumulative or synergistic fashion. Our findings strongly support the use of PDT, especially against Gram positive bacteria, as an anti-bacterial treatment against multi-drug resistant bacteria though further studies **in vivo** are needed to test clinical application.

Key Term: Photodynamic Therapy

CBB-21

UVB Light-Induced Biphasic Activation of PARP-1 in Cultured Human Lens Epithelial Cells

Nahrain Putris (Oakland University), Mason Geno (Oakland University), Mirna Awrow (Oakland University), Advisors: Shravan Chintala and Frank Giblin (Oakland University)

Cataracts are the leading cause of blindness worldwide. UVB light can produce cortical cataract, an opacity occurring in the periphery of the lens, possibly through damage to DNA present in the lens epithelium. Here, we investigated the role of Poly ADP Ribose Polymerase-1 (PARP-1) in protecting the lens epithelium against UVB- induced DNA damage. Cultured human lens epithelial cells (LECs) were irradiated with UVB light (312nm peak wavelength) for 2.5 minutes at an intensity of 0.9 mW/cm^2, and then cultured normally. Immediately after UVB exposure, the cells exhibited damage in the form of contraction and threadlike structures, but without substantial cell death, as well as formation of DNA single-strand breaks as determined by the Comet assay. Activation of PARP-1 was assessed by immunocytochemistry using a fluorescent antibody specific for PAR polymers. Analysis indicated the presence of a low level of PAR in the cell cytoplasm prior to UVB exposure. Five minutes after exposure, PAR levels increased dramatically in the cytoplasm, and distinct movement of PAR from the cytoplasm into the cell nucleus was observed. A second, larger peak of PAR movement into the nucleus occurred 90 minutes after UVB exposure, and was accompanied by a burst of reactive oxygen species (ROS) formation as determined with use of a fluorescent ROS detection kit. The results indicate that UVB light produces both direct and indirect damage to lens epithelial DNA by initial absorption of UVB by DNA, followed by ROS-induced damage. PARP-1 participates in the repair of both types of UVB- induced DNA damage.

Key Terms: Cell Biology
                  Biochemistry
                  Eye Research

CBB-22

Uncovering Oxytocin Signaling in a Single Cell

Michelle Chiu (University of Wisconsin–Madison), Patrick Halbach (University of Wisconsin–Madison), Nathaniel York (University of Wisconsin–Madison), De-Ann Pillers (University of Wisconsin–Madison), Advisor: Bikash Pattnaik (University of Wisconsin–Madison)

Oxytocin (OXT) is a neuropeptide hormone traditionally recognized as an endocrine and paracrine signaling molecule during childbirth using a G-protein coupled receptor (GPCR) mechanism. Our lab has shown that OXT localizes to the cone photoreceptor (PR) outer segments whereas oxytocin receptor (OXTR) localizes to the retinal pigment epithelium (RPE). Thus, it is tempting to predict that OXT release from PR activates OXTR in RPE as a paracrine signaling mechanism. This study investigated the OXT-OXTR proposed GPCR signaling mechanism by using human embryonic kidney (HEK293) cells, an ideal cellular model to study cell-cell signaling.

HEK293 cells stably expressing OXTR (HEK-OXTR) were generated using nucleoporation and selected for receptor expression using blasticidin resistance. Stable HEK-OXTR cells were used for live-fluorescence imaging experiments that visualized several key points of the predicted GPCR mechanism. FURA-2AM and the 340/380 ratiometric assay determined changes in intracellular calcium. Our results demonstrated a rise in intracellular calcium upon OXT stimulation comparable to the positive control, ATP. Two fluorescent fusion constructs; pH-GFP (an indicator of the singling molecule phosphoinositide) and PKC-GFP (an indicator of signaling molecule diacyl-glycerol), caused the expected fluorescent translocation upon agonist stimulation, further indicating that OXT activates OXTR through the GPCR mechanism.

We present visual evidence that confirmed the validity of the HEK-OXTR cell culture model and showed that the OXT-OXTR signaling pathway primarily utilizes the standard GPCR mechanism. The results of this study may be translated to RPE cells to further investigate the role of OXT and OXTR in posterior retinal communication.

Key Terms: Oxytocin
                  G-Protein Coupled Receptor
                  Cell Signaling

CBB-23

Administration of CoQ10 analogue ameliorates dysfunction of the mitochondrial respiratory chain in a mouse model of Angelman syndrome

Arianna Gomez (University of California, Irvine), Katrina Llewellyn (University of California, Irvine), Angele Nalbandian (University of California, Irvine), Advisor: Virginia Kimonis (University of California, Irvine).

Angelman Syndrome (AS) is a neurodegenerative disorder, symptoms of which include intellectual disability, microcephaly, epilepsy, impaired motor coordination, and speech impairment. AS is caused by a number of genetic alterations, but predominantly caused by deletion of the *E6-AP Ubiquitin E3 ligase* (*UBE3A*) gene on chromosome 15q11-13 on the maternal allele. Due to genomic imprinting of the paternal allele, UBE3A expression is silenced in certain regions of the brain, mainly the hippocampus and cerebellum. Our previous studies in the maternally-deficient *Ube3a* AS mouse model revealed a structural mitochondri-

al defect and significantly decreased activity of complex III, critical for the electron transport chain (ETC), in the hippocampus. In this study, we analyzed the effects of a Coenzyme Q_{10} (CoQ_{10}) analog, Idebenone, in this mouse model. We hypothesized Idebenone would improve the flow of electrons in the ETC and alleviate the symptoms of AS. We analyzed changes in coordination and behavior post-treatment with a variety of tests and found an improvement in motor coordination with the Rotarod assay and increased activity in novel environments with a marble burying assay in *Ube3a* AS mice after 3 months of Idebenone treatment. Immunohistochemistry (IHC) and Western blot revealed increased expression of mitochondrial complex III and COX IV in the hippocampus of Idebenone treated *Ube3a* AS mice. These results suggest that treatment with a CoQ_{10} analogue, such as Idebenone extends not only to disorders of CoQ10 biosynthesis in mitochondrial diseases, such as Leber's hereditary optic neuropathy (LHON), but potentially could alleviate symptoms in patients with Angelman Syndrome.

Key Terms: Angelman Syndrome
Therapeutics
Mitochondrial Dysfunction

CBB-24

An Alternative Method for Aptamer Discovery Based on the Human Genome

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The objective of this research project is to investigate an alternative pathway towards aptamer discovery based on DNA sequences found within the human genome. Aptamers are single-stranded DNA or RNA sequences that can adopt many conformations to bind to a variety of target molecules with high affinity and specificity. One structure of aptamers is the G-quadruplex (G4) structure. The current method used for aptamer discovery, SELEX, is not efficient and can underrepresent G4 structures. G4 motifs are prevalent throughout the human genome, particularly in human oncogene promoter regions, and may play a significant role in biological systems. Our method involves the use of DNA sequences based on G4 oncogene promoter regions as potential aptamer sequences. After immobilizing these potential aptamers on the surface of magnetic beads, we incubate with protein nuclear extract from cancer cells, and collect any captured proteins. The captured protein mixtures, screened through MALDI-MS, are then separated through gel electrophoresis, digested into peptide fragments with the enzyme trypsin, and analyzed to uncover their probable identity using LC-MS/MS. These experiments will enable the discovery of new aptamer sequences that may hold biological significance and provide an understanding of the affinity interactions between aptamers and their target proteins.

Key Terms: Cancer
Aptamer
DNA

CBB-25

MALDI-TOF LP, ISD, PMF, and PSD in the Determination of Four Distinct Proteins: An Advanced Biochemistry Laboratory

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Four different monomeric proteins were analyzed using MALDI-TOF Mass Spectrometry: equine myoglobin, bovine serum albumin (BSA), bovine calmodulin, and bovine cytochrome c. Proteins were individually analyzed by four methods of MALDI-TOF: linear positive (LP), in-source decay (ISD), peptide mass fingerprint (PMF), and post-source decay (PSD). Each method identifies a protein in a different way. In LP, the whole protein molecular weight is determined. For ISD, the whole protein is shot with a laser pulse and the amino acid sequence can be found at breaking points on the protein. The tryptic digest of each of the four proteins were analyzed by PMF and PSD. The PMF method measures the masses of the individual peptides – specific to differences in the size and sequence of the protein. The PSD method sequences one of the most abundant peptides. Prior to submission to *J.Chem. Ed.*, the entire experiment will be tested in an advanced biochemistry teaching laboratory in the Spring of 2015. This experiment, along with our recent publications of laboratory experiments involving ultracentrifugation, chromatography, PAGE, and MALDI, compete a set of OMICS teaching experiments meant to introduce students to modern biotechnology instrumentation.

Key Terms: Proteomics
MALDI-TOF
Mass Spectrometry

CBB-26

Elucidating the Role of Yak1 in Saccharomyces cerevisiae

Adeline Boettcher (North Central College), Zachary Laidley (North Central College)

The *DYRK* family of kinases has been highly conserved in eukaryotic evolution and are associated with a number of human diseases. In *Saccharomyces cerevisiae, YAK1* is homologous to *DYRK1a*. By investigating the functions of Yak1p in *S. cerevisiae*, we may be able to understand how the *DYRK* kinases are involved with these diseases. We first aimed to determine if the transcription factors Ino2p, Sfl1p, Tec1p, and Phd1p regulate *YAK1* expression. Western blot analysis shows that Yak1p levels are substantially higher in *ino2Δ* yeast. In a second experiment, we aimed to determine if *Yak1p* alters the association between the subunits of protein kinase A. Yeast two hybrid experiments show that Yak1p may negatively regulate the interaction between the catalytic subunit Tpk1p and regulatory subunit Bcy1p. Thirdly, yeast two hybrid experiments have also shown that Yak1p associates with the P-body protein Pat1p. *pat1Δ* strains have diminished long term survival, and it was found that deletion or overexpression of Yak1p did not change this phenotype. In a fourth experiment, plasmid loss assays were completed; compared to wildtype cells, *pat1Δ* strains have higher levels of plasmid loss. The effect of overexpressing Yak1p could not be determined due to positive vector control results. Finally, it has been found that Yak1p associates with Ypl247p, which causes glycogen accumulation in cells when deleted. *β-galactosidase* assays were completed to determine the transcription levels of Gsy2p , glycogen synthase, are dependent on Yak1. The role of Yak1p in this pathway is again undetermined due to positive vector control results.

Key Terms: Molecular Biology
Proteins
Cell Biology

CBB-27

Dye-Coupling between Motoneurons and Non-Cholinergic Neurons in the Neonatal Mouse Spinal Cord

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Locomotion, the ability to move from place to place, is a behavior that all animals will exhibit at one point in their lives. The neonatal mouse spinal cord provides an excellent model for studying locomotion *in vitro*. We begin our investigation on spinal cholinergic neurons, in particular, motoneurons, which give rise to the ventral roots that innervate muscles. Motoneuronal excitation will result in muscle contraction. Interneurons within the spinal cord organize the activity of motoneurons during locomotion. In this present study, we investigated the possibility of electrical coupling – via gap junctions – as a means of communication between motoneurons and interneurons. Electrical coupling has been reported within various spinal neuron groups including Renshaw cells, Hb9 interneurons, and motoneurons. Few studies report coupling between motoneurons and interneurons despite the presence of diverse connexins in the mammalian spinal cord. In those that have found coupling, it has been restricted to sexually dimorphic motoneurons. To investigate the presence of gap junctions, we evaluated the extent of intracellular dye coupling using neurobiotin (a small molecule known to pass through gap junctions), by backfilling motoneurons projecting into the L6 (lumbar, sixth segment) ventral root. We found that motoneurons were dye-coupled to non-cholinergic neurons that we presumed were interneurons. In addition, we found contralateral L6 motoneurons were also dye-coupled. Together, our data suggest there exists a network of spinal neurons coupled via gap junctions which could potentially be engaged during locomotion.

Key Terms: Neuroscience
Gap Junctions
Spinal Cord

CBB-28

Exploring the Efficiency of the Codon Optimized Flippase in Vivo

George Chen (Burnaby North Secondary), Advisor: Dr. Zhong-Wei Zhang, PhD. (The Jackson Laboratory)

Sites-specific recombinases (SSRs) mediate DNA inversions, insertions, and other genomic exchanges, revolutionizing genetic research and application. Paired correctly with its specific site, SSRs can be used to cure gene related diseases through unique DNA recombination methods. Multiple systems are required to correct mutations in different genes. Compared to the more efficient Cre, the relatively newer technology of the SSR flippase (FLP) yields a low percentage of recombination both *in vivo* and *in vitro*, leading to a codon-optimized version of FLP (FLPo) being developed. *In vitro*, FLPo increased recombination efficiency to a level similar to those observed with Cre. My research goal is to compare the efficiency of FLPo and Cre *in vivo*. The result of FLPo tested *in vivo* is expected to

directly correlate to those found *in vitro*. In this study, using the C57BL/6 mouse, we generated two mouse strains, one with a fluorescent reporter mouse strain carrying FLPo driven by *Pvalb* (parvalbumin) promoter (i.e., *Pvalb*-FLPo strain) and another strain carrying the fluorescence reporter tdTomato. Recombination efficiency of the *Pvalb*-FLPo was tested by crossing these two mouse strains, followed by preparing brain slices for observation using a Zeiss Axio Imager.Z2 con-focal microscope. Through examining the fluorescence expression pattern and intensity, we have observed that cell densities are noticeably dimmer in sections despite an increase in exposure, indicating that FLPo is less efficient than Cre *in vivo*. We aim to explore further methods to enhance the efficiency of FLPo both *in vitro* and *in vivo*.

Key Terms: Neuroscience
DNA recombination
Image analysis

CBB-29

Fine Focus

Primary Authors: Amie Cipolla, Ball State University; Alysha Ellison, Ball State University; Advisor: John McKillip, Ball State University

The American Association for the Advancement of Science (AAAS) call to action emphasizes the need for a re-evaluation of undergraduate biology education. Integration of creative student research into existing curricula and 'community-based participatory research' are major themes of this announcement. *Fine Focus*, a product-based course at Ball State University, is uniquely poised to meet this call to action and is well positioned to take advantage of many rapidly evolving objectives in undergraduate science education. Utilizing the skill sets of dedicated undergraduate students spanning several departments, *Fine Focus* is developing into a peer-reviewed journal whose mission is to publish findings of international undergraduate microbiology research in both print and electronic platforms. By partnering with the American Society for Microbiology (ASM), as well as other scientific coalitions, participating students to gain a multitude of experiences and establish permanent professional contacts in varied subdisciplines of microbiology. Such experiences yield a working knowledge of scientific writing, editing, peer review, graphic design, and advertising, as they relate to dissemination of microbiological research data through an academic journal. In order to be successfully implemented, contemporary undergraduate research in the biosciences must incorporate professional dissemination in addition to bench skills. *Fine Focus* fills this unique niche. Our proposed work is the first international undergraduate journal specifically in microbiology. *Fine Focus* allows interested students the opportunity to see their research efforts through to fruition *via* publication while learning about the scientific peer review process at the same time.

Key Terms: Microbiology
Undergraduate Research
Journal

CBB-30

Understanding the Role of Drebrin in Neuroblast Migration

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Postnatal neurogenesis, a process linked to memory, mood and learning persists in two main niches in the mammalian brain: the hippocampal dentate gyrus and the subventricular zone (SVZ). SVZ-derived neural progenitors migrate tangentially along the rostral migratory stream (RMS) towards the olfactory bulb (OB) where they differentiate into interneurons. Although several cell adhesion molecules, growth factors, axon guidance receptors, and neurotransmitters control neural progenitor migration, how these cues couple with intracellular signaling pathways is still unclear. Understanding the molecular mechanisms underlying neural progenitor migration may grant insight in developing therapeutic approaches to repair the nervous system.

The actin filament-binding protein drebrin couples microtubules to filopodia. We found that drebrin is highly expressed in growth cones of migrating neuroblasts in the RMS, and that drebrin knockdown disrupts neuroblast polarized morphology and migration. Cdk5-dependent phosphorylation of drebrin at Serine-142 was recently shown to regulate microtubule-F-actin coupling. Our goal is to uncover the functional role of this phosphorylation in neuroblast migration by using phospho-dead (S142A) and phosphomimetic (S142D) constructs. We performed *in vivo* postnatal electroporation of GFP-tagged S142A and S142D drebrin constructs in mice coupled with spinning disk confocal microscopy of acute brain slice cultures and RMS explants. Quantitative analysis of neuroblast morphology and migration dynamics indicates that *in vivo* overexpression of drebrin wildtype, S142A, and S142D significantly disrupts neuroblast morphology and polarity, substantially impeding migration along the RMS and integration in the OB. Our analysis suggests that phosphorylation at S142 must be tightly regulated for proper migration of SVZ-derived neural progenitors.

Key Terms: drebrin
neurogenesis
microfilament proteins

CBB-31

Effects of Serotonin on Seizures in DS and GEFS+ Knock-in Drosophila

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Mutations in the voltage-gated sodium channel gene *SCN1A* cause a wide spectrum of epilepsy disorders, from the mild form of genetic epilepsy with febrile seizures plus (GEFS+) to the severe form of Dravet Syndrome (DS). GEFS+ is characterized by childhood onset febrile seizures that persist beyond six years. In DS, seizures appear within the first year of life, can lead to cognitive impairment by the age of two, and are often resistant to pharmacotherapy. We used two knock-in fly lines, one with GEFS+ (K1270T) mutation and one with DS (S1231R) mutation, as model systems to search for new therapies. Consistent with disease symptoms in humans, GEFS+ and DS flies exhibit heat-induced seizures and the seizure phenotype is more severe in DS compared to GEFS+ flies. Our initial studies focused on monoamine signaling since we found that seizure-sensitivity was altered in DS and GEFS+ flies in a genetic background (white eyes) that affects monoamine levels. Feeding adult flies for 3 days with the serotonin precursor, 5-hydroxytryptophan (5-HTP), significantly reduces seizure sensitivity in a dose-dependent manner in DS mutants, but increases seizures in GEFS+ mutants. Injecting serotonin, 5-hydroxytryptamine (5-HT), into the dorsal vein of adult flies also significantly reduces seizure sensitivity in DS mutants one hour post-injection although the magnitude of reduction is less than induced by feeding. These data demonstrate that manipulation of serotonin signaling can result in both acute and long-term suppression of heat-induced seizures in DS flies, suggesting this pathway as an alternative therapeutic target for treatment of DS.

Key Terms: Epilepsy
                     Sodium channels
                     Serotonin

CBB-32

Biochemical Studies of Circularly Permuted Adenylate Kinase Genes to Examine Effects on Protein Stability and Activity

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Designing proteins with new or improved functions and properties, such as increased stability, altered substrate specificity, and increased catalytic activity, is a major focus of protein engineers and can still be challenging. Protein engineers have used many directed evolution strategies to achieve these goals, such as mutagenesis or recombination. This research aims to study effects of another type of mutation called circular permutation (CP) on protein stability and activity. By connecting the native protein termini via a covalent linker and creating new termini elsewhere in the peptide backbone, CP can disrupt local tertiary structure and protein dynamics, as well as affect the catalytic function. In this project we are studying how CP can be used for directed evolution by protein engineers to diversify and tailor protein structure and function.

Previously, libraries of permuted adenylate kinase (AK) genes were created and mined for AK variants that retained function. We chose active variants from these libraries and cloned them into overexpression vectors a with 6X His tag using the Golden Gate DNA assembly method and achieved 97% success on building perfect clones. Furthermore, we overexpressed permuted AK clones in *Escherichia coli* and purified the AK variants using nickel-nitrilotriacetic acid (Ni-NTA) metal-affinity chromatography. For the next purification step, we used Cibaron Blue affinity chromatography with Fast Protein Liquid Chromatography (FPLC) and also tried a HiTrap Phenyl Sepharose hydrophobic interaction column as well. Our results reveal that using either column achieves a >90% clean protein before performing the enterokinase reaction to remove the 6X His tag. However, the enterokinase reaction produces some nonspecific cleavage products visible on our SDS-PAGE protein gels that we have not yet been able to successfully remove with any columns. Further optimization of this step is needed to ultimately compare CP AK mutant stability and activity to wild type. Performing biochemical assays to determine the effect of CP on structure and stability will eventually be probed using circular dichroism, and changes in catalytic activity will be analyzed by utilizing an end point catalytic activity assay. Based on results from Bae et al.'s AK recombination paper, we expect to find that CP in the AK core will have greater effects on stability, whereas changes in the AK mobile domains will affect activity to a greater extent. Optimization of these purification methods and subsequent biochemical analyses will provide insight on how CP may be used as a method for protein engineers seeking to alter protein properties through directed evolution.

Key Terms: Protein engineering
                     Circular Permutation
                     Adenylate Kinase

CBB-33

Shear Stress-Mediated Refolding Of Proteins From Aggregates And Inclusion Bodies

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Recombinant protein overexpression of large proteins in bacteria typically results in insoluble and misfolded proteins directed to inclusion bodies. Current techniques for efficient protein refolding *in vitro*, from recombinant expression, are limited. Developing new methods has become a major concern for academic and industrial laboratories. Reported here is the application of shear stress for the refolding of aggregated proteins and the restoration of active protein structures. To accomplish this, the Vortex Fluid Device (VFD), a novel bench top device, was used to introduce fine-tunable shear forces into micrometer wide films for the refolding of natural and recombinant proteins such as hen egg white lysozyme (HEWL), caveolin, and cAMP-dependent protein kinase A (PKA). The proteins were collected from *E. coli* bacterial inclusion bodies, purified, and subjected to VFD treatment, for 0-30 min. The VFD treated proteins were then tested for activity according to protein specific activity assays or enzyme-linked immunosorbent assays. Isolated HEWL from boiled egg white exhibited significant enzymatic activity following VFD treatment for 5 min. Recombinant HEWL and PKA isolated from inclusion bodies, exhibited little to no activity. However, after VFD treatment, 82% and 63% activity compared to wild type protein, respectively, was observed. Proper refolding of VFD treated caveolin was displayed with increased binding to glycoprotein-41, its natural ligand, over inclusion body driven caveolin. Furthermore, CD spectra of VFD treated HEWL and caveolin were found comparable to wild-type, indicating similar secondary structures. In conclusion, VFD treatment provides for an efficient and effective method for refolding proteins in vitro.

Key Terms: Protein Folding
                    Shear Stress
                    Protein Expression

CBB-34

Long-term Survival and Filamentation of Escherichia coli Under Low Salt Conditions

Kailie M. Briza (North Central College), Advisor: Jonathan E. Visick (North Central College).

Molecular damage is a major factor that causes aging and disease. The spontaneous isomerization of the amino acids aspartate and asparagine to isoaspartate can be corrected by a protein-repair enzyme, the L-isoaspartyl protein carboxyl methyltransferase (PCM). PCM is crucial for the long-term survival of stationary-phase *Escherichia coli* exposed to denaturing stresses such as methanol, heat, oxidative stress and salt; we hypothesize that a key role of PCM is to maintain the folded state of proteins. Preliminary results suggested that PCM-deficient *E. coli* filament and have difficulty disposing of protein aggregates under low-salt conditions. We measured long-term survival (10 days) and filamentation under low-salt conditions. The wild-type strain, JV1120, had an increased survival rate as compared to a Δpcm mutant strain, JV1121, in LB broth with 0.05% added salt. However, the Δpcm mutant had a higher survival rate in LB broth with no added salt. Filamentation was observed in both strains and supported previous preliminary results except in very low salt conditions. Suprisingly, the data suggested that the chemical chaperone betaine increased filamentation. These data suggest that PCM increases long-term survival at specific low salt concentrations in a complex manner and that filamentation could be part of a response to protein damage in PCM-deficient *E. coli*.

Key Terms: Microbiology
                    Escherichia coli
                    L-isoaspartyl protein carboxyl
                        methyltranferase

CBB-35

A Genetic Modifier Screen in Drosophila melanogaster Reveals Novel Genes Involved in the Response to Mitochondrial Dysfunction

Marisol Zuniga(University of California, Irvine), Olivia Duncan (King's College London), Advisor: Joseph Bateman (King's College London).

Mitochondria are important organelles involved in various cellular processes. Studies have linked the dysfunction of mitochondria to neurodegenerative diseases, like Parkinson's disease (PD). Despite the recognized fact of mitochondrial involvement in neurodegeneration, the cellular response during the early onset of mitochondrial dysfunction is not clearly understood. Through the use of a fly model, we screened for genetic modifiers to uncover potential genes that respond to mitochondrial dysfunction. The *Gal4-UAS* system was utilized to cause mitochondrial dysfunction specifically in the fly wing and then to phenotypically identify genetic modifiers using RNA interference (RNAi). A preliminary cross was conducted to eliminate RNAi lines that produced a wing phenotype in the absence of mitochondrial dysfunction. The remaining RNAi lines were crossed with female flies carrying wing-specific *TFAM* loss-of-function, which causes mitochondrial dysfunction. A wing curl increase or decrease relative to a control indicated that the gene is involved in the enhancement or suppression of mitochondrial dysfunction, respectively. From the preliminary cross, 72 out of 101 genes screened did not cause a wing phenotype and were crossed to the female flies with wing-specific mitochondrial dysfunction. The experimental crosses resulted in the identification of nineteen enhancers and three suppressors of mitochondrial dysfunction. The function of the twenty-two modifier genes ranged from involvement in the G-protein coupled receptor signaling pathway to regulation of synaptic growth at the neuromuscular junction. The discovery of these modifier genes demonstrates there is a genetically complex response to mitochondrial dysfunction and further research is required to understand that complexity.

Key Terms: Neuroscience
                    Mitochondrial dysfunction
                    Genetic screen

CBB-36

Repair of DNA in Hyperbaric Oxygen-Treated Cultured Human Lens Epithelial Cells

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Treatment of humans and animals with hyperbaric oxygen (HBO) is known to cause damage in the center of the lens (leading to nuclear cataract), without affecting the epithelium. Here, we investigated the role of Poly ADP Ribose Polymerase-1 (PARP-1) in protecting cultured human lens epithelial cells (LECs) against O2-induced DNA damage. LECs in MEM medium were exposed for 3 hr to 15 atm of 99% O2, 1% CO2. Immediately after the 3 hr exposure, the cells appeared stressed, were fewer in number, and exhibited significant DNA single-strand breaks, as evidenced by the Comet assay. Immunocytochemistry using a fluorescent antibody to the PAR polymer and a fluorescence reactive oxygen species (ROS) kit were employed to investigate PARP-1 activation and ROS formation, respectively, immediately after, and at 0.5, 1, 2, 4 and 7 hrs after HBO-exposure. For untreated cells, a slight PAR fluorescence was observed in the cytoplasm, but not in the nucleus. Levels of PAR polymers increased significantly in the cytoplasm of the cells from 1 to 7 hrs post HBO-exposure, which coincided with a distinct movement of PAR into the nucleus of some of the cells. In contrast, increased levels of ROS were only detected in the cells (in both the cytoplasm and nucleus) up to and including 1 hr after the O2-exposure. The results indicate that ROS-induced movement of PAR from the cytoplasm into the nucleus plays a key role in the repair of DNA by PARP-1 in the oxidatively stressed lens epithelium.

Key Terms: Opthamology
                    Biology
                    Biochemistry

CHM-01

Exploring the Emergence of Biopolymers in Dynamic Chemical Networks (DCNs)

Junyi Liu (Emory University), Junjun Tan (Emory University), David Lynn (Emory University)

Evolution is a process of diversification and ingenious selection accompanied with increasing complexity to generate the most adaptive intelligent materials in nature. A major milestone in evolution was the emergence of biomolecules which could polymerize into specific sequences, and fold and organize to give rise to new functions. To investigate the selection of biopolymers, we have developed strategies for constructing dynamic-chemical-networks (DCNs) through reversible N,O-acetal linkage by reducing the C-terminal of the short peptide into an aldehyde. The resulting bisfunctional peptide can naturally self-assemble and oligomerize to generate a DCN of peptide oligomers. We designed Ser-Thr-Phe-aldehyde (STF-CHO) and hSer-Thr-Phe-aldehyde (hSTF-CHO) based on amyloid self-assembly propensities to (1) select for specific oligomers able to self-assemble into ordered structures, (2) explore the environmental responsiveness of the DCN's component distribution, and (3) compare the relative stability of five-membered-ring STF-CHO vs six-membered-ring hSTF-CHO forming assemblies. We hypothesized that (a) low pH and low solvent polarity would decrease self-assembly and (b) the larger ring size hSTF-CHO would be more stable and aggregate into polymers of larger molecular weight. Our results reveal that the DCN of STF-aldehyde was dominated by cyclic dimer, which is consistent with hypothesis (a) that the DCN is indeed responsive to pH. More data are required to evaluate completely the relative stability of the hSTF DCN of (b). The study on peptide aggregation places physical constraints on direct pathways for peptide evolution in the origin of life, providing methods for manipulating complex environmentally responsive materials that carry sufficient information for self-organizing behaviors.

Key Terms: Dynamic Combinatorial Chemistry
            Peptide Self-Assembly
            Origin of Life

CHM-02

Kinetics and Mechanism of S-Nitrosation and Oxidation of Cysteamine by Peroxynitrite

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The key to understand the physiological role of cysteamine (CA), a drug used in the prevention of hypothyroidism and treatment of nephropathic cystinosis, is through studying the metabolism pathway, its reactive intermediates and oxidation products. As an oxidant and nitrating agent, peroxynitrite (PN), can cause damage to a variety of molecules in cells, including DNA and proteins. This paper reports the kinetics and mechanism of S-nitrosation of cysteamine by peroxynitrite using the methods of spectrophotometry and mass spectroscopy. In highly acidic medium and excess CA, PA nitrosated CA with a 1:1 stoichimetric ratio to form S-nitrosocysteamine (CANO). In the condition of excess PN, a 1:2 stoichiometric ratio was obtained: $ONOO^- + 2CA \rightarrow CA\text{-}CA + NO_2^- + H_2O$. In alkali medium, CA underwent oxidation reactions that yielded a series of products from sulfenic acid, sulfinic acid and then sulfonic acid which was followed by the cleavage of the C-S bond to form sulfate ions. The oxidation of CA was successfully simulated by Kintecus and gave a good fit to the experimental data.

Key Terms: Cysteamine
            Kinetics
            Peroxynitrite

CHM-03

Synthesis of Key Precursors Towards the Lycopodium Alkaloid (+)-Fastigiatine

Christina Owens (University of California, Irvine)
Advisors: Renzo Samame (University of California, Irvine) and Scott Rychnovsky (University of California, Irvine)

Alkaloids found in the Lycopodium family are characterized by unique and complex molecular structures and spark interest due to their diverse biological activities. The use of lycopodium alkaloids in pharmacological research is limited due to the lack of useful synthetic methods to supply material for medicinal studies. The Rychnovsky group is investigating methods for the synthesis of the lycopodium alkaloid, (+)-fastigiatine. The two objectives of this project are, first, the preparation of a functionalized *cis*-decaline and, second, the synthesis of amino acid-derived coupling partners. The decaline system has been made in a multi-step, large-scale synthesis from (*R*)-pulegone. In addition, various reducing agents were investigated for a selective reduction of the ketone moiety present on decaline. Once reduced, the resulting alcohol was protected and is ready for further modifications. Additional details on the synthesis of the precursors of fastigiatine as well as future directions will be presented.

Key Terms: Synthetic Chemistry
            Natural Products
            Alkaloids

CHM-04

Development of Peptide Based Nancomposite Scaffolds for Enhanced Attachment and Proliferation of Chondrocytes

Grant Knoll (Fordham University), Advisor: Dr. Ipsita Banerjee (Fordham University)

Peptide based nanostructures have been gaining increased prominence due to their ability to form permeable scaffolds that allow heightened cell-to-cell interaction, stimulate growth and regeneration of new tissue. In this work, we have utilized a short hexapeptide motif derived from the Tau protein family and derivatized the same with an organic linker in order to promote self-assembly and increased cell-adhesion. Our results showed that nanoribbons and nanofibers were formed over a period of two weeks under aqueous conditions. Furthermore, the formation of those nanoassemblies were found to be pH and concentration dependent with higher yields being obtained under neutral conditions. The assemblies were then used as templates for functionalization with a segment of the dentin sialophosphoprotein motif (GDASYNSDESK) and integrated with a short sequence from spider silk protein with repeats of Ala-Gly. We then incorporated alginate to enrich the properties of the templates by serving as encapsulating hydrogel. Finally, to further enhance binding interactions with chondrocytes, and promote the formation of cartilage *in vitro* we bound the composite biomaterials to the chondrocyte binding peptide sequence. The thermal properties of the composites were examined by differential scanning calorimetry. To confirm biocompatibility, we examined cell proliferation and proteoglycan synthesis in the presence of the chondrocytes. The cells were found to efficiently adhere to the composites and continued to proliferate. The biodegradability of the assemblies was also studied. Thus, we have developed a new family of scaffolds that may be used as potential scaffolds in tissue engineering applications for cartilage tissue regeneration.

Key Terms: Tissue Engineering
Peptide Based Scaffolds
Chondrocyte Profileration

CHM-05

Development And Validation Of RP-HPLC Method Using Photo Diode Array Detection For Simultaneous Quantification Of Dipivefrin And Its Active Metabolites Co-eluting In Pharmaceutical Samples

Lina A. Alaydi (Nova Southeastern University, Fort Lauderdale, Florida), Advisor: Mutasem M. Rawas-Qalaji (Nova Southeastern University, Fort Lauderdale, Florida)

Epinephrine (Epi) intramuscular injection (IM) is the drug of choice for first-aid treatment of anaphylaxis in community sittings. Our previous studies showed that epinephrine 40 mg administered using novel rapidly disintegrating sublingual tablets (RDSTs) is bioequivalent to epinephrine 0.3 mg administered IM in a rabbit animal model. Dipivefrin (Dp) is an epinephrine prodrug has better biopharmaceutical properties than epinephrine and hence betters bioavailability. This study developed and validated an RP-HPLC chromatographic method to separate and quantify co-eluted Dp and its active metabolite in standardized pharmaceutical samples, for Dp analysis following RDSTs sublingual administration. Different strengths of mobile phases were evaluated using methanol and acetonitrile. Reversed-phase C18 columns, at various flow rates using (Waters Alliance System) with PDA detector were evaluated. A 2.0 mg/mL standard stock solution of each compound, Dipivefrin.HCl (Dp.HCl) and Epinephrine.HCL (Epi.HCl) were prepared in 0.0015N HCL solvent. Results showed a reliable method separate, detect and quantify Dp and Epi, using C18 column (3.9mm X 300mm, 10μm), flow rate of 1.5 ml/min at wavelength of 254 nm. The appropriate ratio of Acetonitrile was adjusted in the mobile phase to modify the USP method for Dp analysis [24 (ACN): 15 (0.014 M SDS): 1(Acetic Acid)] Epi.HCl eluted at 1.8 min, while Dp salt eluted at 4.3 min. The linearity of injections, reproducibility of quantification, minimum detection limit, and the intra- and inter-assay variation and calibration curves for each compound were tested and validated RSD≤ 2.0. The DP.HCl salt has the potential to be used in RDSTs.

Key Terms: Chromatography
Method Development
Prodrug and Metabolites Analysis

CHM-06

Purification of Synthetic Oligodeoxynucleotides via Catching by Polymerization

Suntara Fueangfung (Michigan Technological University), Advisor: Shiyue Fang (Michigan Technological University)

Synthetic oligodeoxynucleotides (ODNs) nowadays are needed for preclinical research, patient use, and biological studies. These ODNs are synthesized on an automated synthesizer. Besides full-length ODN, the synthesis generates impurities including failure sequences, which are difficult to remove. The reason is that they have the same properties as the full length ODN. Currently, ODN purification technologies can remove those impurities, such as reverse phase high-performance liquid chromatography (RP HPLC), anion exchange HPLC, polyacrylamide gel electrophoresis (PAGE). However, all these methods are inconvenient for high-throughput purification. To solve the problem, two non-chromatographic methods of ODN purification by polymerization have been developed. In the first method, during automated synthesis, the full-length ODN was tagged with methacrylamide phosphoramidite containing a cleavable linker while the failure sequences were not. After the synthesis, the full-length ODN was incorpo-

rated into a polymer through radical acrylamide polymerization. All failure sequences and other impurities were removed by washing. The full-length ODN was obtained by cleaving from the polymer. In the second method, the failure sequences were capped by a methacrylamide phosphoramidite, and followed by radical acrylamide polymerization. Water extraction retrieved the full-length ODN. Both methods gave pure ODN in excellent yields, and the purity of ODN confirmed by RP HPLC was satisfactory. The identity of ODN was established by comparing with authentic ODN and Matrix Assisted Laser Desorption Ionization-Time of Flight (MALDI-TOF) analysis. These methods do not require any expensive equipment and materials. As a result, they are useful for large-scale ODN purification.

Key Terms: Nucleic Acid Chemistry
DNA purification
Polymer Chemistry

CHM-07

Utilizing Hybrid Nano-Composite Materials to Increase Specific Capacitance for Supercapacitor Applications

James Brooks Mitchell (UNC Charlotte, Advisor: Jordan C. Poler (UNC Charlotte)

As demand for renewable energy such as solar, wind, and tidal increases, an efficient means for storing this energy must be available in order to make these systems cost efficient. Supercapacitors have shown to be a promising answer to this demand due to high specific capacitance or energy storage when compared to the common parallel plate capacitor. Additional advantages include charge-discharge rates, cycle lives, and working-temperature range. However, some areas that need to be improved before practical use are the cell potential, specific energy, and production cost. To improve the specific energy of supercapacitors, metal oxides are currently being researched to add additional energy storage capabilities through a property called pseudocapacitance. Pseudocapacitance, a common property of most metal oxides, is the energy derived due to oxidation-reduction reactions occurring between the surface of the material and the electrolyte being utilized. We have successfully added additional energy storage through the pseudocapacitance mechanism by fabricating hybrid electrodes of Nickel Oxide nanoplates composited with a conductive Carbon nanotube network. Contrary to preliminary research, it was concluded through Scanning Electron Microscopy (SEM) and surface area analysis that the synthesis of the desired Nickel Oxide nanoplate morphology does not require the costly surfactant Hexadecyltrimethylammonium Bromide (HTAB). Lastly, an effective method of electrode fabrication and testing was achieved in order to mimic common industrial processes using a Lithium-ion battery casing. These hybrid nano-composite electrodes show promising results of increased specific energy as well as a decrease of production cost compared to the current commercially available supercapacitors.

Key Terms: Physical Chemistry
Electrical Energy storage

CHM-08

Cytotoxicity of Coating Agents Hexadecylamine and CetyltrimethylammoniumBromide to Human Skin Cells

Eybriunna Lewis (Tougaloo College), Ying Zhang (Jackson State University), and Hongtao Yu (Jackson State University)

As the development of nanotechnology continues to expand, it is essential to determine the toxicity of nanoparticles. The coating agent of nanoparticle determines its shape and size, stabilize the nanoparticle, and enables it to be a useful for biomedicine applications. The coating agents must be considered for toxicity studies of the nanoparticles since they are an intergral part of the nanoparticles. In this experiment, we report the cytoxicity of two commonly used coating agents, cetyltrimethylammonium bromide and hexadecylamine, on human epidermal (HaCaT) cells by MTSAssay and Trypan Blue staining. We found that with 2 hour exposure, cetyltrimethylammonium bromide is toxic at 100 μM, and hexadecylamine is not toxic. For 24 hour exposure, cetyltrimethylammonium bromide is toxic at 30 μM and hexadecylamine is toxic at 100 μM.

Key Terms: Cytotoxicity
Nanoparticles
Coating Agents

EEB-01

Rhizobia Decrease Indirect Defense of Lima Bean (Phaseolus lunatus): Less Extrafloral Nectar and Fewer Ants

Adrienne Godschalx (Portland State University), Advisor: Daniel Ballhorn (Portland State University)

Many plants maintain symbiotic relationships with multiple partners that do not interact directly, but are connected through their common host. Understanding the functional interplay of symbionts associated with the same host remains an important challenge in biology. Here we show nitrogen-fixing rhizobia alter the plant chemistry and defensive strategy of lima bean (*Phaseolus lunatus*) by differentially affecting direct and indirect defenses against herbivores. We inoculated lima bean plants (R+) with a natural rhizobium strain and measured nutritive and defensive plant traits for young, intermediate, and mature leaves in comparison to rhizobia-free (R-) controls. Furthermore, we experimentally induced indirect defense (extrafloral nectar; EFN) and subsequently counted ants attracted to each plant. Rhizobia increased cyanogenesis, a constitutive direct chemical defense against herbivores, but decreased inducible EFN production to 0.5mg sugar g^{-1} dw in plants with rhizobia, relative to 1.6mg sugar g^{-1}dw in rhizobia-free controls. R+ plants attracted significantly fewer ants (mean= 0.9 ants) than R- plants (mean= 2.6 ants). The fundamentally different rhizobia-mediated effects on simultaneously expressed defensive plant traits indicate rhizobia can have significant bottom-up effects on higher trophic levels. Lower ant recruitment in R+ plants likely resulted from decreased EFN, which may be the side-effect of a carbon tradeoff within the plant between EFN and rhizobia. Our results show belowground symbionts can play a critical and underestimated role in determining complex aboveground interactions.

Key Terms: Ecology
                      plant defense
                      mutualistic interactions

EEB-02

Facilitating Host Contact: Can Marine Cercariae Use Gravity To Find Their Next Host?

Kimberly Fitzpatrick (Eckerd College), Nancy Smith (Eckerd College), Jonathan Cohen (University of Delaware)

Many species of marine larvae use gravity as an exogenous cue for orientation and dispersal, but it is unclear if marine parasites exhibit similar geotactic behaviors. Using two species of marine cercariae, *Euhaplorchis* sp. and *Probolocoryphe lanceolata*, which utilize the same first intermediate host (mangrove snail), we tested the hypothesis that cercariae use gravity to position themselves in the water column to increase the probability of contacting their second intermediate host (fish and crabs, respectively).

Under dark laboratory conditions, the geotactic behavior of the cercariae was measured in a sealed test chamber and recorded with a closed-circuit video recording system. The chamber was initially oriented horizontally, then was turned vertically. The position of the cercariae was recorded at 0 (initial), 3, 5, and 10 minutes thereafter. Cercariae found in the top section of the chamber were recorded as displaying negative geotaxis, while those at the bottom were identified as exhibiting positive geotaxis. We found that *Euhaplorchis* sp. cercariae displayed negative geotaxis by swimming towards the top of the chamber, increasing the probability of finding their second intermediate host, killifish. In contrast, *Probolocoryphe lanceoloata* cercariae swam downwards, towards the bottom of the chamber. This positive geotactic behavior would place them in a benthic microhabitat where their second intermediate host, burrowing crabs, are found. Active swimming near the top or bottom of the sealed chamber suggest that cercariae utilize geotactic behaviors that place them in the preferred microhabitat of their second intermediate host, thus ensuring the completion of their complex life cycle.

Key Terms: Geotaxis
                      Parasitology
                      Trematode

EEB-03

Classification Of Low Complexity Regions Based On Sequence Conservation

Sophia Chaudhry (Oakland University), Advisor: Fabia Battistuzzi (Oakland University)

Low complexity regions (LCR) are repetitive sequences of amino acids that are widespread in eukaryotic proteins, particularly in the *Plasmodium* genus. These regions evolve more quickly than other portions of the protein due to amino acid expansion/contraction and substitution. Additionally, homopolymeric regions (HPRs), which are a subset of LCRs composed of a single amino acid, have been shown to also vary greatly in size. Therefore, the expectation from comparative analyses is that LCRs, and HPRs in particular, will be poorly conserved across species. To test this hypothesis, bioinformatics tools were used to compare seven genomes in *Plasmodium* (five *P. vivax* strains, one *P. cynomolgi*, and one *P. knowlesi*) and classify HPRs in categories based on their conservation level. Contrary to what was expected, we find 30% of proteins with HPRs are conserved within *P. vivax* strains and 3% are conserved among all seven species. The results suggest a potential functional role of the conserved HPRs, such as maintaining pathogenicity of the organism, which we will investigate in correlation to protein function.

Key Terms: Evolutionary Biology
                      Bioinformatics
                      Infectious Diseases

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EEB-04

Thermal Stress in Snails Accounts for Fluctuating-Temperature Effects on Parasite Production

Elizabeth Scott (Oakland University), Karie Altman (Oakland University), Jason Sckrabulis (Oakland University), Advisor: Thomas Raffel (Oakland University)

Temperature is known to influence production of parasite infective stages by snail hosts. However, less is known about how thermal fluctuations influence snail-parasite interactions. Predicting parasite responses to temperature variability requires an understanding of how the host's thermal history influences parasite and host performances at the current temperature. Two mechanistic hypotheses have been proposed to predict how thermal history affects temperature-dependent physiological performance. The "beneficial acclimation hypothesis" postulates that physiological performance of an organism at a specific temperature will improve after acclimation to this temperature. The "thermal stress hypothesis" postulates that exposure to stressful temperatures is energetically costly and reduces subsequent performance at any temperature. Results from a previous study revealed complex patterns of parasite production by snail hosts in response to temperature shifts, which were best explained by reductions in host energy reserves following exposure to stressful temperatures (i.e., the thermal stress hypothesis). In this study, we further tested predictions of this hypothesis by measuring the temperature-dependence of snail metabolic processes, following acclimation to one of three temperatures. Our results supported predictions of the thermal stress hypothesis, indicating poor respiratory performance by warm-acclimated snails, and a greater increase in mass loss due to respiration than in mass assimilation from food at warmer temperatures. This resulted in net mass losses by snails held at warmer temperatures, indicating energetic stress at these temperatures. Results from this study will be used to parameterize models of parasite production by snails in fluctuating-temperature environments, with potential applications for predicting disease risk from snail-borne parasites.

Key Terms: Ecology
              Thermal Biology

EEB-05

Tardigrades in the Canopy of Kansas

Alexander Young (Lewis & Clark College), Advisor: William Miller (Baker University).

Tardigrades are a phylum of microscopic animals relatively under-studied from both an ecological and systematic perspective. They can be found on every continent living in habitats such as lichens, moss, algae, and soil: they are remarkable for the breadth of environmental conditions they can tolerate. Given their potential to occur in many places, we examined the vertical and horizontal distribu-tion of tardigrade communities in mixed deciduous forests eastern Kansas. As part of a summer REU project (Research Experiences for Undergraduates) we ascended into forest canopies of eastern Kansas and collected more than 8,000 specimens representing over twenty species. Our findings represent some of the first quantitative information on the ecology of this phylum in canopies. Here, we present evidence that diversity, density, and species richness of tardigrade communities increase with sample height. Tardigrade communities were also affected by forest location, tree species, and habitat type. Additionally, four of the species discovered in the canopy are new to science. I am in the process of describing one of these species.

Key Terms: Tardigrade Ecology
              Spatial Distribution
              Canopy Biology

EEB-06

Modeling Ecological Networks

Matthew Widjaja (Richard Stockton College of New Jersey), Frank Malatino (Richard Stockton College of New Jersey), Advisor: Jason Shulman (Richard Stockton College of New Jersey)

The power in which invasive species have in altering their newfound ecosystem can be devastating. This raises the stakes for scientists to try to control the spread of invading organisms. While several computational models, such as Lotka-Volterra's model, have been developed to study ecosystems, the adaptation of these models to solve practical problems is extremely challenging. Experimentally obtaining the required parameters would not be practical and is often unfeasible.

To avoid these difficulties, my research group and I developed an effective model, which can be constructed with a relatively small amount of data and does not suffer from the same complications as more conventional methods. The effective model can be used to predict network behavior and, more importantly, allows one to calculate the actions necessary to control the network, e.g. reduce an invasive population.

To test these ideas, we generated a synthetic, computer-based ecological system created using the classic Lotka-Voterra model, which acted as a proxy for an actual ecosystem. It provided synthetic data from which the effective model could be generated. We found that the effective model successfully predicted the behavior of the synthetic system, and we were able to use it to control the network, indicating that such an approach will prove useful with actual ecosystems. By creating a more simplified model of ecological networks, we will be better suited to challenge the boundaries and powers that invasive species hold in their new territories.

Key Terms: Ecosystems
              Modeling
              Lotka-Volterra

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EEB-07

The Effect of Windthrow on Forest Insect Diversity and Bird Feeding

Alice Henry (Hamilton College), Advisor: Ernest Williams (Hamilton College)

Disturbance has long been viewed as a source of disruption and damage to an otherwise stable and balanced ecosystem. More and more studies, though, have shown that disturbance is rather necessary to the functioning of a healthy ecosystem. However, most research on the effects of disturbance focuses on sessile organisms and only alludes to the effects disturbance may have on communities of mobile insects. We hypothesized that the areas in the Hamilton College Kirkland Glen affected by the microburst from the summer of 2011 would show higher vegetation densities and thus a more diverse array of insects than surrounding forests. We further predicted that the more diverse insects would also attract more predators, particularly birds. Through vegetation density measurements, pitfall traps, and monitoring feeding rates of fake bugs from a feeding tray, we obtained results that support our hypothesis. This research shows initial support for disturbance as inherent to a diverse ecosystem and further supports the precepts intrinsic to Pickett and White's patch dynamics theory. Though more research needs to be conducted on the effects of disturbance on mobile organisms, our findings support that disturbance maintains diversity of mobile organisms among gaps in the canopy.

Key Terms: Forest Ecology
                Natural Disturbance
                Patch Dynamics

EEB-08

Bacterial Inhibition of Watermolds

Kori Sye (North Central College), Jacob Nesemeier (North Central College), Advisor: Dr. Nancy Peterson (North Central College)

Over the past 40 years, amphibian populations have been declining partly due to infections by water molds. Bacteria have been found to inhibit the growth of the water mold; we hypothesized that the inhibition is dependent on more than the ability of bacteria to change the pH of the environment. We grew Saprolegnia sp.-2013 on LB plates buffered at pH 6, 7, 8, and 9 and compared this growth to Saprolegnia sp.-2013 on buffered plates with Bacillus anthracis Sterne present. We found that the water mold was more inhibited on the buffered plates when B. anthracis was present (F=15.507, p <0.001). We also hypothesized that different water molds will be inhibited differently by bacteria. We found that Phytophthora sp.-2014 was inhibited more by bacteria on protein-rich media (p<0.01). To investigate whether or not water molds compete in nature, we plated two different water molds on vary media. On nutrient-poor and glucose-rich media, the water molds coexisted, while on protein-rich media, Saprolegnia sp.-2013 out-competed Phytophthora sp.-2014.

Key Terms: Ecology
                Biochemistry
                Environmental Science

EEB-09

Whose Nest Is Best: The Allometry of Habitat Creation by Nest-building Birds and Implications for Secondary Nester Conservation

Jessica Mailhot (University of Vermont), Advisor: Clive Jones (Cary Institute of Ecosystem Studies).

An important consequence of ecosystem engineering is habitat creation, which fosters higher biodiversity. One such example is bird nesting behavior of which there are two main facets: primary nesting species build their own and secondary species choose from those already constructed by others. Because of the nest's integral role in breeding success, a strategy is necessary when either building or choosing the best sized nest. We used allometric relationships between body size and nest volume to investigate the role of body size in these two nesting strategies for 323 primary species and 37 secondary species globally including 5 nest types: cup, shallow, cavity/burrow, and orb. Primary nest volume shows a significantly greater scaling than geometric expectations (Expected=1, Actual=1.1287, CI 97.5%:1.05-1.21, R^2=0.60, p<0.001). Secondary nesters chose primary nest volume substantially greater than the primary strategy predicts (70.3% secondary species above predicted volume). It is improbable to find the perfect nest, so secondary species more often prefer larger nests than smaller. There are relatively fewer large primary species making large nests (Slope=-0.5985, CI 95%:-0.796932 – -0.4682862, R^2=0.16769, p<0.001), thus secondary choice is not simply based on which volume is most abundant. Large primary species are therefore more important to biodiversity via habitat creation. This was tested using an extinction simulation model which predicts that secondary species suffer the most from extinctions of larger primary species than those of other body masses. Larger primary birds support relatively more secondary species and should be the focus for conservation efforts to effectively preserve and foster biodiversity.

Key Terms: Ecosystem Engineering
                Allometry
                Animal Behavior

EEB-10

Red Water Of Mesodinium Blooms In The Columbia River Estuary Contain Elevated Levels Of Euduboscquella, A Parasitic Dinoflagellate That Infects Tintinnid Ciliates

Deirdre McAteer, Peter Kahn, Advisor: Dr. Peter Zuber (Center for Coastal Margin Observation and Prediction, OHSU)

Mesodinium rubrum, a mixotrophic ciliate, is known to form non-toxic red tides (red water) around the world in estuaries, fjords, and major upwelling areas along the coast. The exact triggering mechanism that initiates the formation of the red water blooms is unknown in the Columbia River estuary; these blooms have been used as an indicator of environmental health and play a major role in cycling nutrients throughout the lower trophic levels of the estuary. The blooms also encourage the rapid growth of bacterial populations and could potentially promote propagation of species that prey upon *M. rubrum,* such as the toxic dinoflagellate *Dinophysis.*

Initial screening of *M. rubrum* samples for dinoflagellate species did not detect the presence of *Dinophysis,* but instead uncovered an abundance of *Euduboscquella,* a parasitic dinoflagellate known to infect tintinnid ciliates. Certain species of *Euduboscquella* possess in their genome a unique area of sequence polymorphism (henceforth referred to as the Unique Sequence Element, or USE) in the 28S rRNA gene. Analysis of this USE region in water samples from the Columbia River Estuary showed that large populations of *Euduboscquella* occurred during bloom periods, however FISH and DAPI staining microscopy did not show any infected *M. rubrum* cells. While further evidence is needed, it is possible that *Euduboscquella* populations are found in conjunction with bloom periods due to an increase in tintinnid populations.

Key Terms: Organismal Biology
                        Microbiology

EEB-11

Middle East Respiratory Syndrome and Severe Acute Respiratory Syndrome- An Epidemiological Comparison

Charis Royal (Arizona State University) Advisor: Gerardo Chowell (Arizona State University)

Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV) are closely related in the phylogenetic tree of novel coronaviruses that have generated infections in humans. While case and death counts for MERS follow an almost continuous uptick trend in the Arabian Peninsula since June 2012, our basic epidemiological understanding of MERS is limited, extending into unknown areas such as transmission mechanisms, dynamics of human spillover events, natural animal reservoirs and its potential to generate a pandemic. To contribute to this gap, we conducted a comparative epidemiological study using epidemiological data for MERS-CoV and SARS- CoV patients to assess differences in distributions of age and gender reported cases, frequency of health-care related infections, health outcomes, and the case fatality ratio for different wave periods. Our results indicate that MERS-CoV affects a disproportionate number of males between 40-50 years old particularly those with comorbidities. Health care worker incidents increased the risk of infection in both diseases. The case fatality rate for MERS-CoV cases ranged from 46 to 60% compared with a case fatality rate at 9.6% for SARS-CoV. MERS-CoV could have pandemic potential particularly if its transmissibility increases to be comparable to that of SARS-CoV. Based on this epidemiological analysis, MERS-CoV could prove to yield a higher mortality burden than SARS-CoV given the current epidemiological patterns.

Key Terms: Comparative Analysis
                        Epidemiology
                        Statistical Analysis

ENG-01

Screening of Lithium Oxygen Cathode 3D Composite Nano-networks Enabled by M13 Phage Directed Synthesis

Loza Tadesse(Minnesota State University Moorhead), Advisor: Jacqueline Ohmura(Massachusetts Institute of Technology (MIT)),Advisor: Dahyun Oh(MIT) and Advisor/PI: Angela Belcher (MIT)

Lithium air batteries have captured the world's attention due to their ultra high energy density among chemical batteries. There is a need for a cathode that will provide sufficient surface area for the reduction of oxygen and the reverse chemical reactions efficiently. Current research efforts have worked to identify the best materials to complete these tasks, but few direct comparisons exist which decouple material effects from differing morphologies. This study utilizes the M13 phage as a biotemplate in order to create lithium air cathodes of several materials, Ni, Co, Au, Au/Ni, with a comparable, customizable morphology. Performance of these lithium air batteries was then enhanced by exploring different ways to improve the cathode synthesis process Cathodes were made from Co, Ni, Ni/Au, and Au all with similar morphologies. The porosity, wire thickness and type of metal deposited were varied while keeping the nano network architecture controlled. The original Ni battery had a specific capacity of 50mAh/g. The use of Co enhanced the performance by 7 folds. Using Cu/Au and Ni with 2.5e12 phage concentration both quadrupled the specific capacity while Ni/Au and Ni with PH 9.5 phage tripled it. The use of SiO2 cathode support showed an average specific capacity of 180mAh/g. In general, this novel method of battery manufacturing is environmentally friendly and exhibits minor energy consumption compared to current synthesis methods making biotemplated cathodes very significant for future clean energy source.

Key Terms: Biomolecular engineering
              Next generation Li-air batteries
              Nanotec

ENG-02

Biomechanical Effects Of Angled Screw Placement On The Fixation Stability Of Long Bone Shaft Fractures

Bich Ngoc Nguyen (Mercer University), Advisor: Ha Van Vo (Mercer University)

Implant failures remain the most challenging issue in orthopedic surgeries. For fixating long bone fractures, internal fixation technique using bone plate and screws is commonly performed. Fixation strength depends on the bone material properties, type of fracture and the geometry of the fixation. Research shows that optimal fixation depends on the number and placement of screws or using bone cement as an adjunct. This study investigates another method to increase fixation strength, placing oblique screw at plate ends. Biomechanical testing including a low cycle fatigue axial test and a compression to failure test are performed on six matching pairs of cadaveric tibias. Osteonomy gap of 1.5 cm is created to mimic an unstable fracture at midshaft. Each bone is fixated using 4.5 mm LC-DCP plates and six cortical screws. Three configurations being studied are all screws being placed transversely (T group), one screw at each plate end being placed at a $30°$ oblique angle with respect to the transverse plane (O_1 group), and two screws at each plate end being placed at a $30°$ (O_2 group). Axial stiffness, deformation, strength (in terms of yield force and maximum force) and energy absorption are reported to assess the mechanical properties of the bone construct. Overall, the O_1 group demonstrates superior mechanical properties in response to axial forces. In human body, forces on bones are subjected to complex loading which involve additional bending, tension, and torsion loads. Future studies should investigate other modes of loading to recommend the technique for clinical application.

Key Terms: Biomedical Engineering
              Internal Fixation
              Biomechnical Testing

ENG-03

A Computational and Statistical Analysis Examining the Impact of Polymers, Orientations, and Structure on Organic Solar Cell Performance using a Semi-Empirical Monte Carlo Model

Pranav Kemburu (North Carolina School of Science and Mathematics), Advisor Adrienne Stiff-Roberts (Duke University)

Organic solar cells show potential for producing cheaper energy than other available alternative energy sources. With an active layer created out of a polymer:fullerene blend, organic photovoltaic (OPV) cells are more versatile than inorganic solar cells. Despite these advantages, OPV's demonstrate lower efficiencies than inorganic due to fundamental differences in the physics of device operation. One way to raise the efficiency is to better understand how polymers, molecular orientations and structure impacts device performance through the Dynamic Monte Carlo (DMC) simulation. The DMC simulation models the power converting process within cells; examining the particles interacting within, thus allowing testing of polymers PCDTBT, PSBTBT, PCPDTBT, PTB7, and P3HT. The DMC simulation is conducted using electrical parameters, such as carrier mobilities. Within our study we include new parameters, [100] and [010] stacking determined by GI-WAXS measurements, that have not been implemented before, and examined the effects of replacing PEDOT-PSS

with Graphene Oxide. It is shown that Graphene Oxide is a slightly less efficient hole-transporting layer. Our simulation showed an efficiency preference for the [010] orientation, with the rare polymer preferring the [100]. This differs from previous works, and shows the potential for interesting studies on how orientation can impact OPV's.

Key Terms: Material Science
             Computational Analysis
             Organic Solar Cells

ENG-04

Novel Solar Fuel Production of Hydrogen Gas Using Plasmonic-Assisted Heterogeneous Catalysis

Grace Xiong (North Carolina School of Science and Mathematics), Advisor: Niko Hotz (Duke University)

See abstract in the Program Update.

Key Terms: Plasmonics
             Hydrogen Gas Production

ENG-05

Osmotic Dehumidification

Ariel Girelli (University of Connecticut), Advisor: Arthur Kesten (Nanocap Technologies)

Nanocap Technologies has created a novel approach for dehumidification, which combines two simple processes: capillary condensation and osmosis. A semipermeable membrane is placed between the humid airflow and an osmotic agent. As the humid air passes over the membrane, gaseous water molecules condense on the membrane surface just as water condenses on the side of an ice-cold glass of water on a humid day. The semipermeable membrane has pores creating a tortuous path through its surface. Because the membrane sits atop an osmotic solution, the water in the pores is pulled through the membrane and into the osmotic solution. In doing so, the pores clear out and more vapor is allowed into the membrane creating a continuous cycle.

Nanocap Technologies has created a method for environmental control with a number of significant advantages. Using conventional methods of dehumidification, air has to be cooled to the dew point and then reheated to the desired temperature for dehumidification to occur. This process is energy intensive and environmentally risky. Utilizing membrane dehumidification, humidity and temperature can be controlled independently of one another allowing significantly improved energy performance. By eliminating

any stagnant water in the system, bacterial growth concerns is also eradicated. Finally, mechanical repairs are minimized because our system requires few moving parts.

Our innovative approach to environmental control revolutionizes an industry that has remained relatively unchanged for over a century. The progress made will inevitably lead to financial and ecological improvements in residential, commercial, industrial and automotive environment control.

Key Terms: Osmosis
             Dehumidification
             Chemical Engineering

ENG-06

Fabrication and Characterization of Metal-Patterned $SrCo_{0.9}Nb_{0.1}O_{3-\delta}$ Thin Film Cathodes with Well-Defined Geometry

Iwnetim Abate (Minnesota State University Moorhead), Advisor Sossina Haile (California Institute of Technology)

A major obstacle to the study of fundamental properties of candidate cathode materials is the morphological complexity of the electrode-electrolyte interface in fuel cells. This complexity prevents a true determination of the catalytic mechanisms. To address this challenge, photolithography patterning technique has been used to make considerably simplified and well- defined electrode geometries. However, the time required for such fabrication is extreme. In this work, we employ a simple shadow-mask-patterning method to fabricate a perovskite oxide-metal composite structure. First, a dense thin film of $SrCo_{0.9}Nb_{0.1}O_3$ (SCN) is grown on a $Y_{0.16}Zr_{0.84}O_{1.92}$ (YSZ) single crystal substrate by pulsed laser deposition. Patterned metal layers are subsequently deposited by DC sputtering with a shadow mask. Thermal stability and electrochemical properties of the fabricated composite cathodes are investigated by optical microscopy, scanning electron microscopy and AC impedance spectroscopy (ACIS).

Key Terms: Applied Physics
             Material Science
             Renewable Energy

ENG-07

Damage Precursor Detection in Polymer Matrix Composites

Elizabeth Nofen (Arizona State University), Jin Zou (Arizona State University), Yingtao Liu (University of Oklahoma). Advisors: Lenore Dai (Arizona State University) and Aditi Chattopadhyay (Arizona State University).

Catastrophic damage in materials, whether it be in an aerospace, mechanical, or consumer application, often occurs suddenly and without warning, resulting in loss of mechanical properties, complete functionality, or even loss of life. Thus, the ability to observe and quantify the amount of damage sustained by a material before ultimate failure is quite desirable in these applications. We have completed the synthesis, characterization, and validation of multiple mechanophores, which are compounds possessing mechanically sensitive chemical moieties that act as sensors for applied stress or strain. We have developed both cyclobutane-based mechanophores, in the form of cross-linked cinnamate polymers, and cyclooctane-based mechanophores, by the dimerization of anthracene moieties with UV light. For the mechanophores studied, when damage is applied and cracks are formed, there is spontaneous bond cleavage in the cycloalkane rings, resulting in an observable fluorescent signal via the recovery of the monomeric structure. We have successfully incorporated these mechanophores into pure epoxy matrices and glass fiber-reinforced composites. Because the fluorescence is generated along propagating cracks, the exact position of cracks can be detected or the amount of cyclic applied damage from fatigue testing can be observed. The utilization of the anthracene chemistry features a number of advantages compared to the cyclobutane chemistry, including an increase in quantum fluorescence yield, a shift to longer emission wavelengths for naked eye detection, damage detection deep within the matrix, and the possibility for early damage precursor detection. Overall, the application of self-sensing mechanophores into polymer matrix composites has been successful.

Key Terms: Chemical Engineering
Mechanochemistry
Polymer Matrix Composites

ENG-08

UV Raman Spectroscopy: A View of One Layer at a Time

Joe Carpenter (Arizona State University [ASU]), Mark Bailly (ASU), Advisor: Zachary Holman (ASU).

Determining the crystalline fraction of microcrystalline films proves useful in determining the film quality which affects optical and electrical properties. In most cases, Raman spectroscopy can be used when the Raman shift for the peak of amorphous and crystalline materials are different. An added challenge is introduced when attempting to analyze microcrystalline films when using a substrate of the crystalline material. A thin film of hydrogenated microcrystalline silicon (μc-Si:H) grown on crystalline silicon (c-Si) is indistinguishable due to the overwhelming c-Si Raman peak for most Raman spectroscopy systems. In the case of silicon heterojunction solar cells, c-Si is used for substrate, hydrogenated amorphous silicon (a-Si:H) for passivation layers, and μc-Si:H for emitter as well as back surface field. These layers pose a challenge to analyzing the amorphous and partially crystalline film individually. I propose UV Raman spectroscopy analysis with a 325 nm helium cadmium laser. This wavelength light penetrates about 10 nm of the film and light much escape in order to be detected. This penetration leaves an effective analysis depth of 5 nm. This depth is well suited for the 5 nm a-Si:H films and 10 nm μc-Si:H while preventing signal from the c-Si substrate. I will present crystallinity calculations from films deposited by plasma enhanced chemical vapor deposition (PECVD) on silicon, glass with a-Si:H and μc-Si:H, and silicon with thermal or PECVD oxide. This application of UV Raman spectroscopy will provide valuable new characterization possibilities for photovoltaics to advance devices and better understand structure effects on performance.

Key Terms: UV Raman Spectroscopy
Nanomaterials
Photovoltaics

ENG-09

Mechanical Properties on Concrete with Fly Ash and Nano-Silica

Elizabeth De la Cruz Torres (University of Puerto Rico, Mayaguez), Advisor: Oscar Marcelo Suarez (University of Puerto Rico, Mayaguez)

New technologies for the construction industry are required to comply with increasingly strict environmental regulations. For instance, reducing cement demand lowers carbon dioxide emissions caused by its production. Industrial waste materials, such as fly ash (FA), possess cementitious properties. In effect, FA resembles cement paste once in contact with water. However, due to a slower reaction, FA decreases the rate of development of properties in concrete at early age. Loss of strength in the presence of FA motivated this research to incorporate a mineral additive to counteract this effect. Nanostructured silica (nS), having an average diameter of 69nm, was used to that purpose. It was found that geometric features and size of FA and nS improved the workability, porosity and strength of concrete. Density, compressive and tensile strength results are obtained at 7, 28 and 90 days of curing. A statistical design and an optimization model were developed from the results acquired by PC, FA and nS components. These generate a controlled experimental process centered on the resistance as a function of these components, with a constant factor of 0.3 water-to-binder ratio. Future work will continue to analyze other mechanical properties of these concrete mixtures; such as flexibility, hardness, creep deformation, fatigue and durability.

Key Terms: Civil Engineering
                      Cement Replacements
                      Concrete

ENG-10

High Speed Imaging and STICS Analysis to Quantify Extra-Cellular Matrix Fiber Stiffness

Horacio Estabridis (University of California, Irvine), Takahiro Ando Ph.D. (University of California, Irvine), Martha Alvarez Ph.D. (University of California, Irvine), Adviser: Elliot Botvinick (University of California, Irvine)

Research over the past two decades has shown that cellular behavior is heavily influenced by the mechanical properties of the surrounding microenvironment. Microenvironment constituents such as extra-cellular matrix (ECM) fibers have been implicated as playing an important role in diseases such as cancer and fibrosis. However, quantifying ECM stiffness on a cellular scale is non-trivial and consequentially it is difficult to quantify its influence on cellular behavior and disease. In response to this problem, our lab is developing a method to quantify the mechanical properties of individual ECM fibers by pairing a high-speed reflection confocal microscope with Space Time Image Correlation Spectroscopy (STICS). Using a modified Olympus DSU spinning slit-disk confocal unit and a Hammamatsu ORCA Flash 2 camera, we will acquire reflection image data at a high rate: close to 100 frames per second at a minimum. In comparison, normal confocal systems image up to 60 frames per second. The images will then be analyzed using the STICS method through which the elastic storage modulus of individual fibers can be estimated. We have successfully built a prototype high-speed confocal microscope and are currently building the next generation. This tool will greatly inform future studies of the interplay between cellular behavior and ECM mechanics by quantifying how mechanics influence phenotype on the cellular scale.

Key Terms: Biophysics
                      Optics
                      Mechanotransduction

ENG-11

Optimum Growth Condition of Galdieria sulphuria With Respect to pH

Gabriela Rodriguez (New Mexico State University), Amanda Lara (New Mexico State University), Shanka Henkanatte Gedara (New Mexico State University), Nagamany Nirmalkhandan (New Mexico State University).

Wastewater Treatment Plants across the country that were built decades ago are now being challenged by increasing wasteloads, stringent discharge and emission standards, rising energy costs, and the need to provide affordable service to the public. On-going research at NMSU has been developing a novel wastewater treatment system that has the potential to meet the discharge standards, generate net energy, and be cost-effective and sustainable. This system employs an acidophilic algal species, Galdieria sulphuraria, capable of removing the nutrients in the wastewater to generate biomass that can be converted to biofuels. The goal of this research was to optimize the growth conditions of Galdieria sulphuraria as a function of initial pH in different growth media. Experiments were designed to determine the time to reach the optimum pH of 2.5, starting from initial pH of 4.0. Results of this study showed that the cultures were able to bring the pH down to the optimal value within 2 days by themselves. This finding will be valuable in full-scale applications of this system in minimizing the cost of pH adjustment for cultivating Galdieria sulphuraria in wastewaters that typically have a pH of 6.5 to 8.5.

Key Terms: Environmental Engineering
                      Biofuels
                      Algae

ENG-12

A Waveguide Filter Bank Spectrometer for Millimeter and Submillimeter-wave Astronomy

George Che (Arizona State University), Sean Bryan (Arizona State University), Philip Mauskopf (Arizona State University), Matthew Underhill (Arizona State University), Hamdi Mani (Arizona State University, Chris Groppi (Arizona State University), Adviser: Philip Mauskopf (Arizona State University)

The next generation of millimeter-wave astrophysical investigations, which should provide deep insights into star formation, the epoch of reionization, and large-scale structure of the universe, require a sensitive, broadband spectrometer operating in the millimeter and submillimeter regimes. Ground-based grating spectrometers represent the state of the art for long-wavelength spectroscopy, but current instruments are large and bulky due to their reliance on optical interference to produce spectra, thus limiting them to a single spatial pixel. Recently, there have been efforts to develop an ultra-compact filter bank spectrometer, which use lithographically-patterned narrow-band transmission line filters instead of optical interference to produce spectra. Development of this promising "on-chip" design, which potentially offers a complete multi-pixel spectrometer only a few square-mm in size, is severely hampered by the erratic behavior of thin superconducting films used to implement the filters and the difficulty integrating the filter bank and detectors on a single chip. We designed, fabricated, and measured a 5-filter test pixel for a novel multi-pixel spectrometer concept that avoids the drawbacks of both grating and on-chip designs by implementing a transmission line filter bank with rectangular waveguide resonant cavities instead of lithography. The first total-power measurement of our test-pixel, which is designed for the WR-10 band and micromachined in aluminum using split-block construction, closely match our designed center-frequencies (80.35 GHz, 90.28 GHz, 90.73 GHz, 91.20 GHz, and 105.1 GHz) and spectral resolving power (R=100). We will next scale our test-pixel to the scientifically important 150-220 GHz band.

Key Terms: Electrical Engineering
Cosmology
Astrophysics

ENV-01

Longitudinal Study Determining Prevalence of Multiple Drug Resistance within Aeromonad Populations from Human Wastewater Effluent and the Rock River

Sarah Stringer (Rockford University), Jason Haggerty (Rockford University), and Advisor: Troy Skwor (Rockford University and University of Illinois College of Medicine)

Aeromonas is ubiquitous, aquatic genus of bacteria with some species that can cause disease among vertebrate taxa. *Aeromonas* is known to infect humans causing furuncles (skin abscesses) in mild infections to more life threatening diseases like necrotizing fasciitis (flesh-eating) and septicemia (blood poisoning). Of the 25 species of *Aeromonas*, the three most common species to infect humans are *A. hydrophila, A. veronii,* and *A.caviae*. As with any human pathogen, antibiotic resistance is a cause for concern and many *Aeromonas* populations are already resistant to common antibiotics like ampicillin and vancomycin making it more difficult to fight infections. We performed a longitudinal study over three years to determine the prevalence of antibiotic resistance, and possible multiple drug resistance (MDR) against six common antibiotics. We also identified species to evaluate if the common human pathogens were among these MDR populations. Analysis of antibiotic resistance was performed using the antibiotic disk method with tetracycline, streptomycin, trimethoprim sulfamethoxazole, gentamicin, ciprofloxacin, and chloramphenicol. Speciation was determined by PCR amplifying and sequencing *gyrB* housekeeping gene. MEGA5.2 software was used to identify homology between unknown isolates and known *Aeromonas* species. Our results show that resistance in the Rock River was fairly small (0.7% MDR) compared to those in the post-chlorinated effluent (6.8% MDR); which is what we would expect to see due to human influence. *Aeromonas veronii* and *A. hydrophila* make up the bulk of the species from both sites. The high prevalence of pathogenic species together with any level of MDR is a cause for concern and warrants further investigation.

Key Terms: Antibiotic Resistance
Waste Water
Bacteria

ENV-02

Runoff Estimation in the Ungauged Catchment Using Hydrological Models and GIS; A case study in North Gondar, Ethiopia.

Demlie Zelelew (Boku University), Hubert Holzmann (Boku University)

Two model approaches were tested in this research work for the estimation of runoff for the un-gauged catchment in the North Gondar . The first approach includes the SCN - CN method , and the runoff was estimated using the empirical formula developed by USDA in combination with GIS and Remote sensing. In the study, the CN map of the catchment has been developed from the combined spatial information of hydrological soil class and land use, finally the combined CN value of the catchment have been used in the estimation of the runoff . Observed discharges for the model calibration were collected using a rated current meter, and rainfall data were also collected by installing three different rain gauges in the catchment so that spatial variation of rainfall in the catchment was taken in to account . Using regression analysis , it was found that there was moderate correlation between predicted and observed values with coefficient of Regression of R^2 =0.63. The second approach was a storage bucket model concept. This approach was a physical based approach, and most of the equations used were based on the physical laws that governs the components of runoff. A storage model equation have been then developed for the catchment through a proper optimization of the parameters after the calibration of the estimated discharges with the observed events using. Moreover, it was also tried to develop the rainfall - runoff relation equation and the rating curve of the catchment.

Key Terms: ungauged cathment
                Curve Number
                Storage Bucket Model

ENV-03

Filamentous freshwater macroalgae as an alternative biofuels feedstock

Jin-Ho Yun (University of Kansas), Val Smith (University of Kansas), Jerry deNoyelles (University of Kansas), Griffin Roberts (University of Kansas), Susan Stagg-Williams (University of Kansas, Advisor: Val Smith (University of Kansas)

Extensive efforts have been made to evaluate the potential of microalgae as a biofuel feedstock during the past several decades. However, filamentous freshwater macroalgae have numerous characteristics that favor their potential use as an alternative feedstock for algal biofuels production. They can easily be cultivated, and also exhibit high rates of areal biomass productivity. In addition, their filamentous growth form can allow significant reductions in harvesting and dewatering costs relative to those for microalgae. We summarize here extensive evidence from the refereed literature that supports the use of freshwater macroalgae as a biofuels feedstock. In addition, we have successfully used hydrothermal liquefaction to produce a green biocrude oil from freshwater macroalgal biomass. Moreover, our comparative analyses of the elemental composition and energy content of dried biomass from 5 genera of freshwater macroalgae suggest that they all compare favorably with traditional bio-based energy sources, including terrestrial residues, wood, and coal. In addition, we performed a laboratory experiment using the common Chlorophyte genus *Oedogonium* to investigate whether nutrient availability can influence its productivity, higher heating value (HHV), and proximate analysis. The most nutrient-limited growth conditions (lowest nutrient supply rates) resulted in a significant increase in the HHV of the *Oedogonium* biomass. These results together suggest that that filamentous freshwater macroalgae have significant potential as a feedstock for both solid and liquid biofuels, especially if nutrient-rich wastewater can be used as the supply of water and mineral nutrients.

Key Terms: Algal Biofuels
                Filamentous Freshwater Macroalgae
                Ecology

ENV-04

Farm-level economic implications of alternative tillage options

Shelby Gibbs (Tarleton State University),Advisor: Hussain Jafri (Tarleton State University), Edward Osei (Tarleton State University)

No-till farming has been documented as having significant potential to prevent soil erosion and preserve water resources. As input costs such as labor and fuel continue to increase, farmers are exploring alternative farming methods besides conventional tillage. The objective of this study was to assess the economic implications associated with no-till farming as compared to conventional or other tillage methods. An annual economic simulation model – Farm Economic Model – was used to simulate the economic impacts of alternative tillage options in croplands in Texas. FEM was calibrated using custom rate data assembled from Texas custom operators during the 2013 production year.

Results of the simulations indicate that crop yield under various tillage practices is a key deciding factor as to the relative profitability of alternative tillage practices. Break even yields of corn, soybeans, cotton, sorghum, and wheat under reduced till, mulch till, and no-till relative to conventional tillage vary significantly depending upon the prevailing crop prices. Historical prices from 1971 through 2013 were used to determine the most likely break even yields that would provide incentive for farmers to switch to tillage practices that preserve soil and water resources. When crop yields are very similar across tillage practices, no till and reduced till practices are more profitable. However, yield penalties are often associated with reduced and no till practices as compared to conventional tillage. Government payments to farmers adopting conservation tillage will minimize concerns about yield penalties they may incur during the initial years after switching from conventional tillage.

Key Terms: No-till farming
conservation
economic

GSC-01

Martian Polar Stratigraphy from High-Resolution Stereo Topography

Patricio Becerra (Lunar and Planetary Laboratory, University of Arizona), Shane Byrne (Lunar and Planetary Laboratory, University of Arizona), Sarah Mattson (Lunar and Planetary Laboratory, University of Arizona), John D. Pelletier (Department of Geosciences, University of Arizona), Kenneth E. Herkenhoff (U.S. Geological Survey), Advisor: Shane Byrne (Lunar and Planetary Laboratory, University of Arizona)

The Polar Layered Deposits (PLD) of Mars are broad sheets of water ice and dust that make up the bulk of the Martian polar caps. Erosional features allow a view of their internal stratigraphy, which is composed of many depositional layers that are thought to represent a record of recent climate change on Mars.

Several researchers have attempted to extract periodic climate signals from images of scarps on the PLD. They created virtual ice cores plotting layer albedo versus depth. These studies generally agree that there is a dominant stratigraphic wavelength of 25–30 m in the upper 300 m of the NPLD.

The major weakness of these studies is the use of albedo as the mapped layer property. The brightness of exposed layers is a complicated product of slopes, frost retention, albedo, and surface texture. So it is not clear how brightness relates to the properties of the layers themselves.
We seek to examine depth-varying properties that are characteristic of the morphology of the layers, using advanced spectral analysis techniques of meter-scale Digital Terrain Models created from stereo images taken by the High Resolution Imaging Science Experiment (HiRISE) in orbit around Mars. We measure how the protrusion of layers from a scarp varies with depth, and take this as a proxy for resistance to erosion. Our goal is to construct a stratigraphic column characteristic of the first few hundred meters of each PLD, and search for climate signals related to variations in Mars' orbital parameters.

Key Terms: Planetary Science
Mars Polar Science
Stratigraphy

MCS-01

Designing a Low Cost Modular Heating/Cooling System

James Schaefer (North Carolina State University), Advisor: Dr. Warren Jasper (North Carolina State University)

In a given year, 32% of the energy costs to run a typical commercial building are attributed to heating and cooling. A majority of the energy and therefore the costs are expended into heating and cooling the rooms and furnishings as opposed to providing comfort to the occupants. With the proliferation of small and inexpensive embedded devices such as the Raspberry Pi and the Arduino, it may be possible to design micro-climate controllers which provide personalized comfort (warmth and cooling) in a distributive environment. Therefore, the heating and cooling is designed around the occupant as opposed to the walls and other surfaces in the room. A first step in designing such an architecture is to decouple the actuation (heating and cooling) from the sensing (body skin temperature and humidity) in the office environment. A battery operated Arduino with a temperature/humidity sensor was embedded into a wearable textile. Temperature and humidity data were transmitted through a router to an SQL database running on a Raspberry Pi which operated fans for cooling based on the user's desired set point temperature. The open-source/open architecture design allows for scalability and reliability in the system.

Key Terms: Computer Science
              Embedded Systems
              Micro-Controllers

MCS-02

Simulation of the Trajectory of a Rocket from the Earth to the Moon Utilizing Heun's Method in MATLAB

Joshua Seol (Milton Academy), Advisor: Chris Hales (Milton Academy)

This research simulates a rocket's launch from the Earth to the moon in a simplified system using a MATLAB program created with functions derived from Newton's laws of motion and Euler's modified method of recursive iterations (Heun's method). The program finds value pairs of launch angle (θ_0) and initial velocity (v0) which successfully allow a rocket to approach the moon's surface from Earth and depicts the process using a display engine created to visually demonstrate the trajectory of the rocket. Assuming the moon's starting position is directly above the earth (90° counter-clockwise from position 0°), this research derives that there are possible pairs of initial launch condition (θ_0, v_0) resulting in a successful landing on the moon. As an example, for a given arbitrary initial velocity of 22.58 km/s perpendicular to the Earth's surface, the range of successful launch angles are $\theta = 92.7 \pm 0.2$ (to the nearest tenth degree).

A few other initial launch conditions were investigated and are shown in Appendix A.

These results exhibit the constant orbit of the moon and its gravitational pull on the rocket as well as the miniscule margin for error present in space travel. The code of the simulation and display for this research is shown in Appendix B.

Key Terms: MATLAB Programming
              Heun's Method
              Basic Rocket Physics

MCS-03

BeagleCache: A Network Accelerator for the Developing World

Dale Markowitz (Princeton University), Advisor: Vivek Pai (Princeton University)

Internet access in developing world countries is expensive in both relative and absolute terms; on the one hand, what we might typically consider low-performance computers can be expensive and valuable at universities in developing world countries. At the same time, the methods by which Internet access is provided to such countries--generally via satellite links--are low-bandwidth and expensive in absolute terms, a consequence of the fact that traditional network links may be impractical to install and maintain in developing-world countries.

One solution to improving the network lag experienced in these regions is to deploy a network of HTTP caching proxies--computers that intercept users' web traffic and cache content, so that future users can load web data from local caching proxies rather than over slow connections across the Internet. Inspired by the recent rise of inexpensive, single-board Linux computers, BeagleCache is a $45.00 caching proxy and web accelerator built atop a credit-card-sized Linux computer known as the BeagleBone Black. We present the BeagleCache networking stack as well as the performance of this cheap but effective device as a caching proxy. By employing methods of peering, caching, compression, and prefetching in the BeagleCache stack, we are able to give Internet users in developing world countries the illusion that their Internet speeds are much higher than what their infrastructural bandwidth physically allows.

Key Terms: Networking
              Caching
              CDN

MCS-04

Classifying The Nonsolvable Quadratic Rational Groups

Stephen Trefethen (University of Arizona), Advisor: Pham Tiep (University of Arizona).

Let G be a finite group. A C-representation of G is a homomorphism, \Phi, from G into a general linear group consisting of matrices with complex entries. For any g in G, we may consider the trace of the matrix \Phi(g). This defines a function, \chi, from G to C, called a character of G. We say that G is rational if [Q(\chi):Q]=1 for any irreducible character \chi of G. More generally, we say that G is m-rational if [Q(\chi):Q] divides m for any irreducible character \chi of G. In this presentation, we will discuss the progress toward classifying the rational and solvable quadratic rational groups, as well as our work with nonsolvable quadratic rational groups. We will present a "hands-on" geometric approach, which is useful in dealing with the linear, unitary, and symplectic groups. Finally, we will briefly mention a more sophisticated method for handling the exceptional groups, namely the implementation of some results from Deligne-Lusztig theory.

Key Terms: Mathematics
              Finite Group Theory

MCS-05

Modeling Traffic at an Intersection

Dennys Rosales (Kennesaw State University), Saniita FaSenntao (Kennesaw State University), Kaleigh Mulkey (Kennesaw State University), Advisor: Anda Gadidov (Kennesaw State University)

The main purpose of this project is to build a mathematical model for traffic at a busy intersection. We use elements of Queueing Theory to build our model: the vehicles driving into the intersection are the "arrival process" and the stop light in the intersection is the "server."

We collected traffic data on the number of vehicles arriving to the intersection, the duration of green and red lights, and the number of vehicles going through the intersection during a green light. We built a SAS macro code to simulate traffic based on parameters derived from the data.

In our program we compute the number of vehicles in the queue every time a vehicle arrives and leaves the intersection, the service time, and the total time the vehicle spends in the queue, or the sojourn time. We describe the probability distribution of the queue length in the long run and analyze its dependence on λ and the durations of the green and red light. Using regression we build a model for the dependence of the average queue length and the average service time on λ and the durations of the green and red light.

Based on the regression results we propose traffic models that achieve optimal queue lengths and sojourn times.

Key Terms: Mathematics
              Statistics
              SAS

MCS-06

Improving Testing Methods for Mobile Applications Using Device-Specific Faults

Katherine Marszalkowski (East Carolina University) Advisor: Sergiy Vilkomir (East Carolina University).

The research focused on improving the methods that are currently used to test mobile applications. Due to the number of mobile devices (smartphones and tablets) on the market and variations in their characteristics, it is hard to guarantee that an application will work on all devices. Faults that are found only in certain devices are known as device-specific faults. The goal of this research was to determine how many devices must be tested and what the best testing method is for revealing device-specific faults. To collect experimental data, 15 Android applications were tested on 30 mobile devices using real devices, TestObject, and pCloudy remote services. A total of 24 device-specific faults were detected. From this data, we analyzed different methods of selection based on the characteristics of each device. The research showed that 13 randomly selected devices achieved 100% effectiveness. However, coverage of the devices' characteristic resulted in an acceptable 95% level of effectiveness with sets of only five devices. The most successful approach concentrated on Android's operating systems. The results indicates which methods will help increase the effectiveness and decrease the costs of mobile testing.

Key Terms: Device-Specific Faults
              Remote Devices
              Mobile Application

PHA-01

Application of Monte Carlo Simulations to Modeling the Irradiation of Biological Material with Soft X-Rays Generated by the CUEBIT

Jared Klingenberger (Clemson University), Donald Medlin (Clemson University), Amy Gall (Clemson University), Roshani Silwal (Clemson University), Adam Klingenberger (Clemson University), Taylor Kimmel (Clemson University), Matt Rusin (Clemson University), Bryana Baginski (Clemson University), Dominika Wisniewska (Clemson University), Dinkle Kaur (Clemson University), Suzanne Bradley (Clemson University), Arthur Hellyer (Clemson University), Sam Caruso (Clemson University), Katelyn Truong (Clemson University), Joseph Wilson (Clemson University), Janet Williams (Clemson University) Jonathon Miller (Clemson University), Kristyn Brandenburg, Jalaan Avritte (Clemson University), R. Kevin Wilson (Clemson University), Advisors: Endre Takacs (Clemson University), Delphine Dean (Clemson University)

The effects of high-energy radiation on biological material are well studied; however, comparably little is known of the effects of low-energy radiation such as soft x-rays on biological material. The Clemson University Electron Beam Ion Trap (CUEBIT) at the Department of Physics and Astronomy is capable of generating low-energy monochromatic x-rays from highly charged ions through charge exchange. These x-rays are ejected from the beam line and controllably directed into other experimental setups. Through collaboration between physicists and bioengineers, an irradiation chamber has been constructed that allows for a flask of biological material to be irradiated by these photons. Flasks containing fibroblast, bone, and cardiac cell cultures have been prepared for irradiation in this chamber. However, the complex intracellular physical interactions upon irradiation of the cell cultures are difficult to understand. Recent research suggests that secondary biological and chemical processes lead to observable cellular effects that are not predicted by simple photon-particle interaction models. Using a software package called GEANT4, Clemson University School of Computing students modeled an ion beam, the production of low energy radiation, and the interaction of radiation with biological material. The dose of radiation in cells can be calculated with the model. Clemson University Department of Bioengineering students can compare these data to experimental results and correlate cellular effects with received dose. Further improvements to the model geometry and the addition of biological and chemical interactions will allow for improved analysis of the multistep processes that occur after the initial irradiation of biological material.

Key Terms: Physics
                     Bioengineering
                     Computer Science

PHA-02

Single Molecule Spectroscopy Using Multiparameter Fluorescence Detection

Luke Tremblay (Clemson University), Advisor: Dr. Hugo Sanabria (Clemson University)

Multiparameter Fluorescence Detection (MFD) takes advantage of the fact that fluorescence information has at least eight dimensions: excitation spectrum, emission spectrum, anisotropy, fluorescence lifetime, fluorescence quantum yield, macroscopic time and the fluorescence intensities influenced by the stoichiometry and distance between fluorophores. The last one is possible thanks to Fluorescence Resonance Energy Transfer (FRET) measurements. To extract the most plausible information regarding fluorescence at a single molecule level we use a home built confocal microscope with pulsed excitation and Time-Tagging acquisition, where each arrival photon is determined by 3 parameters: *i)* Channel number *ii)* Microtime and *iii)* Macrotime. Single molecule events can be analysed in many different ways to provide quantitative information about the state of biomolecules. Among the physical parameters one could extract concentration from pM (10^{-12} M) range, diffusion and rotational correlation times, fluorescence lifetimes and much more. Moreover, intrinsic dynamics of biomolecules from picoseconds to milliseconds can be determined using fluctuation algorithms. In all, MFD is a powerful spectroscopic tool to characterize and analyse biomolecules. Examples on species selection in single molecule spectroscopy and inter-conversion of states from microseconds to milliseconds are presented. In addition, MFD helps to solve most of the common problems associated with quantitative FRET measurements and distance determination. Moreover, we use MFD/FRET to provide distance restrains that will be used for modelling three-dimensional structures of biomolecules with near atomistic resolution.

Key Terms: Biophysics
                     Fluorescence Spectroscopy
                     Single Molecule

PHA-03

Experimental Approach For Circuit Analysis

Frank Malatino (Richard Stockton College of New Jersey), Matthew Widjaja (Richard Stockton College of New Jersey), Advisor: Jason Shulman (Richard Stockton College of New Jersey)

For complex circuits, implementation of Kirchoff's Laws can be tedious and time consuming. Here, we present an alternative procedure, which is based on a methodology designed to control complex networks. It is an experimental, rather than analytical, approach to analyzing circuits. From this, one can generate equations that describe the behavior of a circuit. These are the same equations that would be obtained through more traditional means.

Key Terms: Circuits
              Experimental
              Network

PHA-04

Focusing and Analyzing Sound Waves with Varying Nonlinearity

Thorsen Wehr (Odessa High School)
Adviser: Jeffery Wehr (Odessa High School)

Waves formed in nature are primarily linear and have a property called dispersion, causing different waveforms to separate and lose amplitude. Solitons can retain their pulse form as they propagate and cancel out dispersion, making nonlinear waves useful for transferring energy. Practical medical applications consist of non-invasive tools for eradicating specific cells or military applications such as non-invasive strikes. An acoustic lens used for focusing longitudinal waves was engineered and assembled from chains of metal spheres. Within these chains, waves displayed nonlinear behaviors; the stress from spheres' masses caused deformation in the chain. Variable force was applied to chains depending on the chain number from the desired focal point and direction: center, right, or left. Relative sound amplitude was recorded using a microphone array. The average relative amplitude of the control compared to experimental data at the predicted focal points were significantly different. When observing the wave aspects within each sphere such as wave behavior with varying striking force or examining sphere location, the nonlinearity of higher and lower forces and the nonlinearity of top and bottom test sphere positions were statistically different. This research revealed the non-linear acoustic lens produced increased relative amplitude at specific focal points, and also predicted nonlinear wave production. New biological models have proposed solitons are produced in proteins and DNA, and the brain may send signals using solitons. Since not fully understood, more experimentation must be conducted to achieve a complete understanding of nonlinear waves and produce equations to properly

describe them.

Key Terms: Mechanical Engineering
              Particle Physics
              Theoretical Physics

PHA-05

Novae in Andromeda Galaxy : Spatial Distribution Studies with an Extinction Model

Amanpreet Kaur (Clemson University), Advisor : Dieter H. Hartmann (Clemson University)

Novae in Andromeda (M31) are believed to separate into two distinct populations (bulge/disk). The bulge seems to be more prolific nova producer as compared to the disk of M31, as per observations. These spatial distinctions appear to correlate with their spectral differences (Fe II in bulge , He/N in disk), which are thought to be evolved from two separate binary populations. However, recent observations of novae in the Milky Way have demonstrated spectral transformations from Fe II to He/N and vice-versa, which calls this distinction between two source classes into question. In case of M 31, one such transformation has been observed. We construct a double exponential dust extinction model for novae in M31 in order to investigate the possible selection effects that could play a role in the observed spatial distribution.

Key Terms: Astrophysics
              Cataclysmic variables
              Galaxies

PHA-06

Uncovering the Intrinsic Variability of Gamma-ray Bursts

V. Zachary Golkhou (Arizona State University), Advisor: Nathaniel R. Butler (Arizona State University).

Gamma-ray Bursts (GRBs) are the most powerful explosions of energy in the cosmos since the Big Bang itself.

Although much has been learned in recent years, thanks in large part to the detection of 1000 GRBs with NASA's Swift satellite (~40% of which have measured distances/redshifts), GRBs remain perhaps the most elusive and poorly understood events in astronomy. Despite their presence at cosmological distances, use of GRBs to probe cosmology and the evolution of the Universe has proven difficult. It is remarkable that, despite thousands of observed light curves, even the presence of cosmological time-dilation has never been measured conclusively. Here, we study a novel methodology to potentially do this, while also developing a unique and powerful description of prompt GRB Gamma-ray variability.

Identification of the shortest timescale of intensity variations in GRBs is vital to define the length scales in these explosions and to shed light on the emission mechanism. We study a wavelet formulation for the first order structure function (related to the auto-correlation function) to richly characterize GRB light curve variability as a function of timescale. This approach averages over the time series captured for a given GRB, providing robust measures on minimum variability timescales. We examine how these variability signatures depend on GRB redshifts and other observables, potentially discovering key source frame signatures in the light curves.

Key Terms: Astrophysics
              High Energy
              Gamma-ray Bursts

PHA-07

Study of the Stability of VERITAS pointing using Mrk 421 observations from 2006-2013

Brianna Thorpe (Arizona State University), David Kieda (University of Utah), Andy Smith (University of Utah)

The signature of the emergence of a jet in a galactic object could manifest itself by the change in position of the object. Observations of such an effect would require clear evidence that the telescope pointing had not changed during the time that the change was observed. This can be studied through detailed observations of the location of bright extragalactic gamma ray sources such as Markarian 421. I helped to provide a lower bound on the probability of the emergence of a jet in a galactic object by examining systematic shifts in observations of Markarian 421.

Key Terms: Astrophysics
              Gamma Rays
              Telescopes

PHA-08

Quantum Coherent Manipulation of Two-level Systems in Superconducting Circuits

Alexander Burin (Tulane University), Andrii Maksymov (Tulane University), Kevin Osborn (University of Maryland)

The number one problem for any quantum computer designer is protecting qubit quantum state from decay, thus keeping information undamaged during calculations. Usually it is done by adding error correctors or shadow lattices. But what if we can make the environment of qubits, which usually serves as a source of decoherence, act in a useful way? We introduced an approach that allows one to minimize energy losses in qubits by manipulating surrounding two-level systems (TLSs) in a coherent way through simultaneous application of time-varying bias and continuous microwave fields. Deleterious effects of TLSs can be thus eliminated by the population inversion produced in a Landau-Zener passage of TLSs through resonance with the AC microwave field.

Key Terms: Quantum Computers
              Decoherence
              Population Inversion

PHA-09

The Evolution of Carbon Burning Flames Inside Super-Asymptotic Giant Branch Stars

Carl Fields Jr. (Arizona State University), Advisor: Dr. Frank Timmes (Arizona State University)

We explore how carbon burning impacts the bifurcation region separating stars whose final fate is a massive white dwarf from stars whose final fate is a massive star supernova. A dense grid of models with initial mass between 6 and 11 solar masses are evolved from pre main-sequence to the end of nuclear burning using the open-source toolkit, Modules for Experiments in Stellar Astrophysics (MESA). For stars between 7 and 9 solar masses, energy losses at the center of the core due to neutrino cooling causes a temperature inversion resulting in off-center ignition. First ignition occurs where the minimum temperature of $7 \cdot 10^8$ K, and a density of $2 \cdot 10^6$ g/cc is met. We conclude that for stars within this range, the location of first ignition decreases as a function of initial mass. Moreover, we show that there exist a unique ignition density of $2 \cdot 10^6$ g/cc. All previous calculations assumed a non-rotating, non-magnetic star. Observations show that stars of similar mass are known to undergo differential rotation and are also subject to self-generated magnetic fields. We continue our study by investigating the effects of rotation and self-generated magnetic fields on the evolution of the carbon burning flames. Rotational values of $2 \cdot 10^{-2}$ to $5 \cdot 10^{-1}$ that of the "break-up" or critical rotational velocity will be evolved and assumed to be that of a solid-body configuration starting at zero-age main sequence utilizing the current MESA prescription of angular momentum transport.

Key Terms: Stellar Evolution
              Astrophysics
              Stars

PHA-10

The Occurrence of Electrical Instability and Reentry due to Regional Increase in Extracellular Potassium Ion Concentration

Sunil M Kandel (Oakland University), Advisor: Bradley J Roth (Oakland University)

Ventricular tachycardia and ventricular fibrillation are the two most dangerous arrhythmias. Both are related to reentrant electrical activity in the ventricles. Many studies of arrhythmias consider a homogeneous sheet of cardiac tissue. Since normal ventricular myocardium is inhomogeneous and inhomogeneities play an important role in the induction of reentry, we consider a 2D inhomogeneous sheet of myocardium to investigate the effect of a localized inhomogeniety developed at the border between homogeneous and inhomogeneous region. We used the bidomain model to represent the electrical properties of cardiac tissue and a modified version of the dynamic Luo-Rudy (LRd) model to represent the active properties of the membrane. To investigate the effect of localized inhomogeneity, the extracellular potassium $[K]_e$ concentration is raised to 10 mM from normal $[K]_e$ (4 mM) on the right half of the tissue. A train of cathodal stimuli are applied from the lower left corner of the tissue with a different basic cycle length (BCL). At certain BCL, the spatial heterogeneity created with regional elevation of $[K]_e$ can lead to action potential instability (alternan) in normal and border region, and 2:1 conduction block in ischemic region. We observed the reentry when local heterogeneity in $[K]_e$ is changed from 10 to 12 mM on the right half of the virtual ventricular myocardium sheet.

Key Terms: Computational Modeling of Cardiac Tissue
Arrhythmia: Ventricular Fibrillation
Electrical activity of inhomogeneous cardiac tissue

PHA-11

Study of Stopped Cosmic Muons in the Long Baseline Neutrino Experiment 35 Ton Liquid Argon Detector

Clay Barton (Dakota State University), Jonathan Insler (Louisiana State University), Advisor: Thomas Kutter (Louisiana State University).

The Long Baseline Neutrino Facility is a new neutrino experiment which will perform neutrino oscillation measurements and perform a search for leptonic CP violation. A small scale prototype of the planned liquid argon far detector is currently under construction at Fermilab. This 35 ton prototype will be used to test the performance of the detector components. Results will inform the design for the full scale 34 kiloton detector.

Cosmic rays will serve as signal to measure the response of the prototype detector. Cosmic muons which stop and decay within the detector's fiducial volume provide a characteristic signal, which can be used for calibrations. This study outlines research performed to predict the flux and energy spectrum of through-going and stopped muons. This research resulted in a large simulated data sample of cosmic muons modeled with realistic parameters. The data sample is now in use in simulation studies of the prototype detector's performance.

Key Terms: Particle Physics
Astronomy

PHA-12

Temporal Changes in the Frequencies and Widths of the Solar p-mode Oscillations during the Rising Phase of Solar Cycle 24

Sophia Singh (University of Southern California), Advisor: Edward Rhodes (University of Southern California)

We investigated the temporal changes in the frequencies and widths of the solar p-mode oscillations during the rising phase of Solar Cycle 24 by analyzing a time series of full-disk dopplergrams obtained by the Michelson Doppler Imager (MDI) and Helioseismic and Magnetic Imager (HMI) between late-2007 and mid-2012. The MDI Dynamics Runs obtained between 2007-2012 were divided into 83 three-day time series. The first 792 days of HMI observations were divided into 264 additional three-day time intervals. We computed a set of un-averaged power spectra from all 347 time series. We collapsed the 347 sets of un-averaged power spectra into sets of m-averaged power spectra and subsequently fit more than 12,000 peaks in each of these 347 sets of m-averaged power using a power spectral fitting code. We then performed linear regression analyses of the differences in the fitted p-mode frequencies and widths as functions of the differences in as many as ten different solar activity indices. From these linear regression analyses we extended our previous discovery of unique signatures of the frequency and width shifts of the p-modes into the rising phase of the current Solar Cycle. One key aspect of these signatures is that the frequencies and the widths are both positively correlated with the changes in solar activity at low frequencies before switching to being anti-correlated with those activity differences at higher frequencies. We found that these fiducial freqencies were substantially higher than they were during the 2008-2009 extended minimum of solar activity.

Key Terms: Solar Activity
Solar Oscillations
Dopplergram

PHA-13

The Derivation of Frequency Modulation Equations for Compton Sources

Todd Hodges (Arizona State University/Thomas Jefferson National Accelerator Facility), Advisor: Wally Melnitchouk (Thomas Jefferson National Accelerator Facility).

Thomson sources of electromagnetic radiation utilizing relativistic electrons have seen increased use in fundamental physics research in the past several years. The small frequency range, or bandwidth, of the emitted radiation is highly desirable for applications in nuclear physics, medicine, and homeland security. As the intensity of the incident laser pulse involved in the scattering event increases, the bandwidth of the emitted radiation increases. In accelerators, this increase in bandwidth may be negated through frequency modulation of the laser pulse. However, current analytic solutions governing this frequency modulation are only applicable when the energies of the individual photons in the laser pulse are within the Thomson limit. We derive analytic solutions applicable to laser pulse frequency modulation both within, and outside, the Thomson limit through the use of Quantum Electrodynamics (QED). Specifically, an expression for the differential cross section pertaining to Compton scattering is derived for a reference frame in which both the electron and incident photon are moving. Additionally, an approximation for the differential cross section is derived including first and second order corrections. Progress towards altering the derived expression to include the contribution from multiple photon emitting processes and allowance for specification of incident photon polarization is discussed.

Key Terms: Physics
Particle Physics
Theoretical Physics

PSI-01

Robust ADCC and Virion Capture Activity of Env-specific Monoclonal Antibodies Isolated from Blood and Breast Milk of Chronically Infected African Green Monkeys

Nguyen QN[1], Zhang R[1], Arifin T1[1], Martinez D[1], Stolarchuk C[1], Pollara J[1], Edwards RW[1], Whitaker K[1], Foulger A[1], Amos JD[1], Wang MY[1], Vandergrift N[1], Colvin L[1], Dewar K[2,3,4], Juretic N[2,3,4], Wasserscheid J[2,3,4], Ferrari G[1], Liao H-X[1] and Permar SR[1].

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[2] Research Institute of the McGill University Health Centre, McGill University and Génome Québec Innovation Centre,
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In contrast to HIV-infected women and SIV-infected rhesus macaques, African green monkeys (AGMs), the natural primate hosts of SIV, sustain nonpathogenic infection and rarely transmit the virus to their infants despite chronic viremia and high milk virus RNA loads. Chronically SIV-infected AGMs also exhibit more robust milk and plasma envelope (Env) gp120-specific antibody responses than non-natural hosts that may be associated with the lack of B cell dysfunction. Therefore, characterizing SIV Env-specific memory B cell repertoire in blood and milk of AGMs could help elucidate the Env-specific antibody responses that evolved in this natural host species. Although none of the 10 isolated mAbs neutralized the autologous challenge virus, all 10 mAbs mediated robust ADCC against autologous Env-coated target cells. Gp120-specific mAbs exhibited robust killing activity against gp120- and gp140-coated target cells with endpoint concentration less than 0.1 $\mu g/mL$ whereas gp41-specific mAbs do so only when reacted with gp140-coated targets at higher endpoint titer. Nine mAbs bound to the surface of SIVsab92018 IMC-infected NKR cells, though gp41-specific mAbs bound at low magnitudes. Moreover, 5 gp120-specific mAbs showed robust capture of autologous SIV virions, yet only in the presence of sCD4. Thus, env conformational changes induced by CD4 engagement may increase susceptibility of SIV virions and infected cells to ADCC and virus capture. We speculate that robust virion capture and ADCC activity of the Env-specific B cell repertoire of AGM natural hosts evolved over time, and may contribute to reduced vertical virus transmission in this species.

Key Terms: ADCC
African Green Monkeys
Monoclonal Antibody

PSI-02

Accuracy and Validity of Shoulder Range of Motion Measurements Using a Novel Smartphone Goniometer

David Zhu (Yale University School of Medicine), Jason Young (Yale University), Stacey Gallacher (Yale University School of Medicine), Ruben Vega Perez (Yale University), Karen Sutton (Yale University School of Medicine), Advisor: Theodore Blaine (Yale University School of Medicine)

Introduction: Measurement of joint range of motion (ROM) is an integral part of musculoskeletal examinations, and is essential for evaluating joint functionality, tracking surgical recovery, and assessing treatment efficacy. Given the prevalence of musculoskeletal injuries, having a quick, convenient, and accurate way to measure ROM is essential for healthcare providers. We built a novel smartphone application to measure shoulder and elbow ROM, and presently investigate its accuracy and validity.

Methods: We developed a goniometer application for Android smartphones, which uses the phone's accelerometer and gyroscope sensors to determine the phone's orientation when held by the user. A smartphone running the application was mounted on a custom testing apparatus with a rotating arm. The arm was rotated from 0 to 180 degrees, in 15 degree increments, and measurements from the application were recorded. Each measurement was repeated 3 times to assess validity, and measurements were performed for each of the phone's three axes of rotation. Measurements were compared to actual values using Bland-Altman analysis. Interclass correlation coefficient (ICC) was also calculated.

Results: Measurements were accurate for all three axes of rotation, with ICCs of 0.9978 (x), 1.000 (y), and 0.9997 (z). Bland-Altman analysis showed no trends in measurement deviation for any axis. All measurements were valid.

Conclusion: The ROM measurements obtained from the novel smartphone goniometer are accurate and valid. Clinical trials of accuracy and validity are ongoing. Considering the ubiquity of smartphones and the necessity of quickly and accurately measuring ROM, this application can be an important tool for clinicians.

Key Terms: Medicine
              Orthopedics

PSI-03

Investigation of Adipokine-Induced Activation Responses in Endothelial Cells

Manindra Singh (Ohio University, Athens), Advisor: Fabian Benencia (Ohio University, Athens)

Adipokines are fat tissue-derived signaling molecules that control a variety of physiological functions, including metabolism, insulin resistance, energy balance, angiogenesis and inflammation. Obesity-induced dysregulation in the secretion of adipokines has been reported as a major contributive factor for cardiovascular pathogenesis and metabolic syndrome. Previous studies have shown that various chemotactic and inflammatory signals originating from the visceral adipose tissue may cause the recruitment of leukocytes from the circulation towards the adipose tissue. But the mechanisms that integrate abnormal adipokine function and adipose tissue inflammation are poorly understood. In the present study, the function of adipokines: visfatin, leptin and vaspin was assessed for their capability to induce inflammatory responses in vascular endothelial cells. A large-scale antibody-based protein micro array was used to detect the chemokines secreted by the adipokine-treated cells. Specifically, visfatin treatment upregulated the production of CXCL1, CCL11 and VEGF. Further analysis using enzyme-linked immunosorbant assays revealed that visfatin also upregulated the production of inflammatory molecules: MCP-1 and GM-CSF, by the endothelial cells. Quantitative real-time PCR analysis showed that visfatin induced the expression of inflammatory genes: IL-6, MCP-1 and MMP-9 at the transcript level. Additionally, a colorimetric cell-proliferation assay revealed that visfatin decreased cell viability over the treatment period. Overall, these results indicate that the adipokine visfatin might be involved in the inflammatory activation of endothelial cells and may contribute to inflammation of adipose tissue and pathogenesis.

Key Terms: Adipokines
              Endothelial Cells
              Inflammation

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PR-11

Ecotoxicity of fungicides in aquatic ecosystems under realistic daily temperature regimes

Morgan M. Willming and Jonathan D. Maul

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Fungicides have been detected in aquatic environments, but few studies have investigated their ecotoxicity to shredding invertebrates and the fungal and bacterial communities responsible for the decomposition of organic matter. Organic matter breakdown is important for carbon and nutrient transfer in aquatic food webs. In this study we examined effects of environmentally relevant concentrations of the fungicide pyraclostrobin on leaf processing of the amphipod *Hyalella azteca* and impacts on leaf-associated microbial communities. Because fluctuating temperature regimes may impact toxicity and leaf decomposition, exposures were conducted under two realistic daily temperature regimes: an 18-25°C regime based on field-collected data from the S. Llano River, Texas, or a 20-26°C regime adjusted based on possible climate change predictions. Endpoints included *H. azteca* dry mass, body length, and leaf processing. We also determined ergosterol content of leaf material as a measure of fungal biomass and assessed changes in microbial community function using Biolog EcoPlates. We did not observe any significant effects on ergosterol content or changes in microbial community function as a result of pyraclostrobin or temperature treatments. Leaf processing was slightly increased in the 20-26°C treatment, but there were no significant effects of pyraclostrobin on growth responses or decomposition. These results indicate that environmentally relevant fungicide concentrations may not have large impacts on leaf processing potentially due to functional redundancy in the microbial community. Incorporation of realistic exposure scenarios and fluctuating temperature regimes are important for accurately assessing risk of contaminants on functional ecosystem endpoints.

PR-12

***Centruroides sp*. Scorpion Venoms Cleave SNARE Proteins**

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Cellular SNAREs are membrane proteins integral to vesicular transport, docking, membrane fusion and exocytosis. They are classified as vesicular (v) or target (t). We recently described novel v-SNARE (VAMP2 and VAMP8) cleavage by Antarease, a metalloprotease in venom from the Brazilian scorpion, *Tityus serrulatus*. The research presented here extends the discovery of metalloprotease activity to three North American scorpion venoms: *Centruroides sculpturatus* (CSV), *Centruroides noxius* (CNV), *Centruroides limpidus tecomanus* (CTV). These scorpions are also known to be among the most dangerous to humans. In our previous studies venoms were first evaluated for the ability to stimulate exocrine pancreatic secretion since clinical data had reported pancreatitis in sting victims. Experiments *in vitro* showed that the three *Centruroides sp*. venoms can stimulate pancreatic lobule secretion. In separate studies using pure VAMP2 and VAMP8 recombinant substrates we showed proteolytic activity in these venoms. The cleavage of VAMP2 and VAMP8 was confirmed in electron microscopic images of immunolabeled tissues from *in vivo* experiments. Other evaluations of the effects of these venoms on neuronal tissue homogenates affirmed their SNARE cleaving enzymatic activity. All these findings subsequently pointed to our discovery of a metalloprotease we named Azantarease in the venom of *C. sculpturatus*, native to Arizona. This analogous enzyme shares amino acid sequence homology with Antarease thus confirming the presence of a new class of conserved proteins in New World scorpion venoms. These metalloproteases are distinct from venom ion channel toxins and are likely significant causes of pathological effects of scorpion stings.

Student Research Abstracts

CBB-37

Role of Rho GEFs in Regulating the Epithelial-Mesenchymal Transition during Gastrulation in Chicken Embryos

Ben Van Maren (University of Arizona), James Cooley (University of Arizona), Advisor: Parker Antin (University of Arizona)

During an epithelial-mesenchymal transition (EMT), epithelial cells lose cell polarity and adhesion, migrate away from the epithelium, and become migratory mesenchymal cells. EMT has numerous downstream functions, such as organ formation, gene expression, and germ layer formation. It is a fundamental evolutionarily conserved process that is executed through multiple mechanisms. EMT is also thought to occur during cancer metastasis. Rho GTPases are known to play a central role in regulating EMT. The activation of Rho GTPases is controlled by Rho GEFs and Rho GAPs. This study investigates Rho GEF function during EMT that occurs during chicken embryo gastrulation. In situ hybridization was used to identify Rho GEFs that are expressed during chicken gastrulation and differentially localized around the primitive streak where EMT occurs. Of these, those shown to have an early lethal phenotype when ablated in mice were targeted for further study. Myc-tagged dominant negative and constitutively active forms of these Rho GEFs were created. The constructs were then assayed for their effects on EMT during gastrulation via electroporation into a chicken embryo and immunofluorescence. Several of these constructs affected cell polarity and adhesion. We hypothesize they are activating Rac1, a Rho GTPase. Further investigation will utilize morpholinos to examine the effects of a Rac1 knockout and knockouts of each targeted Rho GEF. This research will lead to an essential understanding of vertebrate gastrulation as well as the underlying mechanisms of cellular metastasis.

Key Terms:	Developmental Biology
		Cellular Biology

EEB-12

Ecosystem Engineering During the Early Cambrian

Claudia Mazur (Mount Holyoke College), Advisor: Doug H. Erwin (Smithsonian National Museum of Natural History), Clive G. Jones (Cary Institute of Ecosystem Studies)

Ecosystem engineers are organisms that create, significantly modify or maintain habitats. Trace fossils burrows providing paleontological evidence of ecosystem engineering became abundant in Ediacaran and Early Cambrian rocks, however not much is known about the organisms that made them. By looking at these ichnofossils and their geometry, specifically length and diameter of burrows, we can determine the allometric relationships between the size of the trace and the engineering effort that went into constructing them. I collected fossil burrow length and diameter measurements from published papers, and I applied an allometric analysis to the data. Similar data have been collected and analyses applied to contemporary organisms, which allows us to compare the modern and fossil burrows in order to better understand and interpret the relationships of Ediacaran and Early Cambrian trace fossils to their environments. Results show that fossil and contemporary burrow lengths have a strong positive allometric scaling with burrow diameter, however the contemporary exponent is far higher than the fossil exponent. Contemporary burrow length and diameter relationships increase at a greater proportion than observed during the Ediacaran and the Early Cambrian. In fossil burrows, the diameter increases, but the length only increases a third of what is seen in contemporary burrows. Constraints during the Ediacaran and Early Cambrian such as low oxygen concentrations in the water column and sediments, and lack of circulatory systems in the organisms could have strictly limited the depth and lengths of burrowing activity during that time.

Key Terms:	Paleobiology
		Ecology
		Cambrian

Student Research Abstracts

EEB-13

Biodiversity And Population Estimates Of Syngnathid Fishes In The Seagrassbeds Of Coastal Texas

Janaeé Wallace (St. Edward's University), Mia Valdez (St. Edward's University), Advisor: Raelynn Deaton Haynes (St. Edward's University)

Due to significant changes in the earth's ecosystems' biodiversity is declining at an unprecedented rate. One major ecosystem affected is seagrasses, which provide critical habitat and nursery grounds for many aquatic organisms, including microbes, invertebrates and vertebrates. Syngnathid fishes (pipefishes and seahorses) have been identified as good bio-indicators of healthy seagrassbeds due to their dependence on the seagrasses for the duration of their life cycle. Thus, assessing biodiversity (species richness and number) and population sizes of syngnathids is vital to our understanding of the health of these ecosystems. This summer (June -July 2014) we assessed population sizes and biodiversity of syngnathids in in the Gulf of Texas. It has been reported that Texas' seagrass beds support six species of syngnathids: three pipefishes (Gulf, dusky and chain) and three seahorses (dwarf, slender and lined). We quantified population size and biodiversity of these fishes using random sampling in three grassbeds (for biodiversity) and the depletion method in two beds (for true population estimates). To date, our analyses show that the Gulf pipefish is the most prominent species present in the area, followed by chain and dusky pipefishes, dwarf seahorses, and lined seahorses. No slender seahorses have been collected thus far. Our analyses also suggest that the depletion methods are valuable for assessing population sizes in the grassbeds, as over time the numbers decreased to nearly zero. We are continuing analyses and will present further results on relative abundance of each species and predicted population sizes.

Key Terms: Ecology
Marine Science
Biodiversity

EEB-14

Female Subjugation in a Sex Role Reversed Pipefish (*Sygnathus scovelli*)

Janaee A.S. Wallace (St. Edward's University), Nancy P. Cisneros (St. Edward's University), Sunny K. Scobell (Brooklyn College), Advisor: Raelynn Deaton Haynes (St. Edward's University)

Dominance hierarchies result in dominant and subordinate individuals, often referred to as social subjugation. Such subjugation is brought by intra-sexual competition via aggression. Competition in females often results in subjugation, or the "shutting down" of reproduction in one female, and in turn, increased investment into growth. Thus, social subjugation can have direct consequences for female reproductive success. Here, we investigated social subjugation over time in a sex-role reversed mating system, *Sygnathus scovelli* (gulf pipefish), where females compete strongly for males. We hypothesized that *social subjugation (through aggressive competition) can drive the formation of dominance hierarchies*. Summer 2013 and 2014, gulf pipefish were collected from seagrass beds around Port Aransas, Texas, and returned to the laboratory at St. Edward's University where behavioral assays were performed. Thus far, our results suggest that: 1) aggression is directly correlated to a female's social status with behaviors such as the temporary melanistic display most heavily influencing the establishment of dominant/subordinate status; 2) morphometric features of females such as standard and maximum body depth influence a female's social status; 3) dominance likely is established on the first day of interactions, with no change within a single female's behavior over time. Overall, our data suggest that females in sex-role reversed species form dominance hierarchies that can significantly influence female fitness.

Key Terms: Behavioral Ecology
Dominance Hierarchies
Sex role reversed organisms

Student Research Abstracts

EEB-15

Mariana Fruit Bat Preference of Native and Non-Native Forage

Acacia Baker (Northern Arizona University),
Nashelly Meneses (Northern Arizona University),
Advisor: Russell Benford (Northern Arizona University)

One of the most important aspects of a species habitat is the availability of its favored forage. A species can become threatened if its favored forage is not readily available. The Marianas Fruit Bat (MFB), native to the Mariana Islands, is a threatened species. One important reason it is threatened is because of the degradation of its native forests. This native forest is home to the MFB favored forage. This study is about whether the MFB shows a preference between its native and non-native forage species. Captive MFB in the Saipan Zoo were observed as to how many times they made contact with the native and non-native forage they were presented. It is expected that the MFB will have more contacts with the native species than the non-native species. Preliminary data shows that the MFB has a slight preference for the native forage over the non-native. Building a diet for captive bats based around their preferred forage could improve the bats health and overall well-being and could help rebuild the population of the Marianas fruit bat.

Key Terms: Conservation Biology
               Marianas Fruit Bat
               Forage

ENG-13

Growth of G. sulphuraria as a Function of Initial pH

Amanda Lara (New Mexico State University),
Advisor: Nirmal Khandan, Shanka Gedara (New Mexico State University)

Over the past few years there has been an increase interest urban wastewater treatment by using mixotrophic algal strains to produce energy-rich biomass as a feedstock for biofuel production. This rationale could be a sustainable approach to replace today's energy-intensive wastewater treatment technologies. On-going research at New Mexico State University has identified an acidophilic and thermophic red algae, Galdieria sulphuraria, capable of growing heterotrophically and autotrophically as a potential strain for removing organic carbon, nitrogen, and phosphates from wastewaters. Previous studies have determined that pH of level of 2.5 as the favorable pH level for G. sulphuraria to maximize its growth and net energy yield with minor impact by predators. As urban waste water is in neutral pH, the cost of pH reduction to take pH to its favarable pH level would be high. The goal of this study is to evaluate growth of G. sulphuraria as a function of initial pH to determine its ability to self-regulate the pH from the initial pH level of around 4.0 to the optimal level of 2.5. Test cultures of G. sulphuraria were grown in borosilicate test tubes in three different growth media to analyze its self-regulating capability in filter sterilized primary effluent compared to standard growth medium. The study showed that G. sulphuraria can self- regulates the pH level from 3.5 to 2.5 in two days in all three media which is highly favorable for large scale cost effective wastewater treatment.

Key Terms: Environmental Engineering
               Galdieria Sulphuraria
               Waste water

Student Research Abstracts

ENG-14

Quantification of leg muscle forces and joint reactions using a novel musculoskeletal model of human cycling motion

Taylor Gambon (Clemson University), Jessica Myers (Clemson University), Randy Hutchison, Ph.D (Furman University), Advisor: John D. DesJardins, Ph.D (Clemson University)

Project Goal: The goal of this project was to create a musculoskeletal model of human cycling motion able to estimate muscle forces and joint reactions based on 3D kinematic trajectory data. An inverse dynamic analysis of the model was performed utilizing AnyBody Technology's (Aalborg, Denmark) musculoskeletal modeling software (version 6.0.3).

Methods: Starting with the MoCapModel template from the AnyBody Managed Model Repository (version 1.6.3), a full body model was fit to the 3D marker data of human cycling motion. Definitions of the body's interactions with the bicycle were determined using three areas of interaction; 1) the subjects' pelvis in contact with the bicycle seat, 2) the subject's hands on the handlebars, and 3) the subject's feet on the pedals. In order to define the motion for the force plate pedals of the bicycle, the ForcePlateType4 class was modified. Kinematic drivers were added to connect the pedal segments to the 3D marker trajectories of the pedals from the motion data.

Results: The Motion and Parameter Optimization sequence and Inverse Dynamic Analysis sequence were validated by the exhibition of traditional knee flexion angle waveforms expected from cycling. Future work will include further validation of the model by comparing electromyography data to the associated estimated forces from the model with regard to ACL rehabilitation loading.

Key Terms: Bioengineering
                Musculoskeletal Modeling
                Cycling Motion

ENG-15

Migratory Patterns in Glioblastoma Subtypes

Benjamin Wissel (The Ohio State University), Deepthi Koralla (The Ohio State University), Aaron Short (The Ohio State University), Tyler Nelson (The Ohio State University), Ichiro Nakano MD, PhD (The Ohio State University), John Lannutti, PhD (The Ohio State Univerity), Advisor: Jessica Winter, PhD (The Ohio State University).

The prognosis for glioblastoma multiforme (GBM) is currently very grim; median survival is 14.6 months for this high grade brain cancer. GBM is difficult to manage, and it is not curable with current chemotherapy or surgical treatment options. Recent evidence suggests that GBM has three subtypes with different genetic expression signatures. Even though prognosis is consistent, the responses to aggressive treatment differ between the subtypes. We hypothesize that these distinct genetic signatures will lead to different migration patterns through activation of different chemical pathways, which may serve as therapeutic targets. To investigate this, electrospun nanofiber models, which mimic white matter tracts, major migratory tracts for GBM metastasis in the brain, were used to compare migration patterns between "Proneural" and "Mesenchymal" GBM cells. Time lapse microscopy indicated that there is a clear distinction in cell adhesion, morphology, and migration speed between "Proneural" and "Mesenchymal" subtypes. This data suggests a potential clinical relevance in the treatment and prognosis of different types of GBM, particularly if the specific chemical pathways involved can be identified. Differences in gene sequences between the two subclassifications indicate relevant proteins for investigation into the possible causes for the variation in migratory behavior.

Key Terms: Cancer
                Biomedical Engineering
                Cell Migration

Student Research Abstracts

ENV-05

Does *Wolbachia* threaten the conservation of an imperiled butterfly?

Amy Truitt (Portland State University), Adviser: Dr. Catherine de Rivera (Portland State University)

Can population augmentation, such as captive rearing and release, effectively conserve imperiled insect pollinators, or are these methods too risky? Augmentation is accomplished by supplementing small unstable populations with individuals of the same species from the same population or from a larger, more stable population. The latter type of augmentation may bring populations together that have historically been separated; i.e. allopatrically. While augmentation programs are generally responsible concerning the release of visibly infected individuals to supplement recipient populations, movement between populations has the potential to spread pathogens. Unknown or unidentified bacteria can be introduced when the source population is infected but the recipient population is un- or differently infected prior to supplementation. Here we examine the temporal sequence and potential consequences of infection to a butterfly undergoing population supplementation. These supplementations are occurring between populations that are infected with symbiotic bacteria, *Wolbachia*, which can decrease population viability.

Despite management actions including habitat restoration, habitat enhancement, and captive rearing and release, some of these populations remain severely susceptible to extirpation. This has compelled us to investigate whether CI-inducing *Wolbachia* serves as a potential additional variable contributing to attrition of *S. zerene hippolyta* populations. This study investigates 1) whether donor populations has different strains of *Wolbachia* from the recipient ones suggesting that the captive rearing and release program accidently introduced new strains; 2) whether there are differences in reproductive success between infected and uninfected females; and 3) the potential ramifications that introduced *Wolbachia* has on populations of pollinator species of conservation concern.

Key Terms: Endangered Species
                        Conservation
                        Wolbachia

PSI-04

Short Term Release from Calcium Sulfate and Polymethyl Methacrylate Beads

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This project involves juxtaposing antibiotic elution rates from two common bone cement beads, polymethyl methacrylate (PMMA) and $CaSO_4$, when impregnated with the antibiotics vancomycin, tobramycin, and usnic acid, alone or in various combinations. In an attempt to preserve a primary joint or prevent a possible second infection after revision of a total joint arthroplasty, PMMA and $CaSO_4$ beads are commonly infused with antibiotics because of their ability to elute locally high concentrations of them. By investigating this juxtaposition, it can be determined which cements' antibiotic elution rate has the greatest efficacy in treating and preventing a simulated bacterial infection in vitro. In previous studies, antibiotic-infused beads were placed onto a plate at the same time it was inoculated with bacteria in order to determine its' zone of inhibition (ZOI). However, this does not correlate with medical practice as beads are utilized once an infection has already been suspected or identified. Thus, our proposed experimental method simulates a better clinical application of these beads by first establishing a lawn of *Pseudomonas aeruginosa* and *Staphylococcus aureus* onto separate plates and then introducing the beads to determine their respective ZOI's. PMMA's antibiotic elution rate and ZOI will be compared to the $CaSO_4$ beads to determine which will be of better potential service to the site of total joint replacement. Our most recent work will allow us to relatively align the ZOI assay with the diffusion of antibiotics by using fluorescein-infused PMMA and $CaSO_4$ beads to analyze fluorescein's diffusion characteristics through an agar plate.

Key Terms: Orthopaedic Implants
                        Microbiology
                        Infection

Student Research Abstracts

PSI-05

The Mechanistic Involvement of Ion Channels in Glioma Cellular Metastasis and Proliferation

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Glioma is a form of brain cancer that is diagnosed in approximately 18,000 people in the United States every year. Unlike other cancers, glioma does not metastasize by traditional means. Instead, malignant cells migrate by moving across interneuronal spaces. It is hypothesized that ion channels play a critical role in altering the cellular shape and volume, necessary for this intercellular migration. The goal of this project is to identify the current state of knowledge on the involvement of ion channels in the metastatic process. We performed a comprehensive review of the published literature (PubMed-Medline) following the guidelines established by the PRISMA guide lines. These methods included identification of a topic; selection of articles based on specialized criteria; design and implementation of a data extraction form; and synthesis and appraisal from the selected articles to diminish bias. Inclusion criteria included articles that were case reports, clinical trials, *in vitro* studies, journal articles, validation studies, and introductory journal articles. Further inclusion criteria consisted of articles that focused on migration and or proliferation and the involvement of K^+, Cl^-, Na^+, and Ca^{2+} channels. 30 articles were selected form an initial PubMed screen that yielded 823 literature entries using "ion channel glioma" as search criteria. Seven of the 30 selected articles did not meet this study's previously stated criteria so data was extracted from 22 articles. In this study, the current role of K^+, Cl^-, Na^+, and Ca^{2+} channels in glioma metastasis and proliferation are clearly reviewed and understood.

Key Terms: Cancer Biology
Drug Targeting
Cellular functionality

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