Student Project Showcase 2010 (draft as of 5/11/2010 12noon)

Entry Number: 1 GL

FEASIBILITY OF USING SALIVA AS A BIOSPECIMEN FOR BREAST CANCER SCREENING IN WOMEN

By: Cathy Samayoa
Cell and Molecular Biology
Faculty Advisor: Dr. Leticia Marquez-Magana

Abstract: Despite the higher breast cancer incidence in White women, African American women have a higher mortality rate and this disparity is growing. Current screening methods aim to detect breast cancer at early stages to improve prognosis. The rates of breast cancer screening vary between ethnicities, and minority women get screened later. Some of the barriers with traditional screening methods, such as mammography, include changing guidelines, lack of access to health care, mistrust toward the healthcare system and social/cultural factors. Preliminary data shows that African American and Latina women feel more comfortable donating saliva than any other biospecimen. A more affordable and culturally-acceptable screening method that detects cancer biomarkers in saliva via 1H nuclear magnetic resonance (NMR) would increase screening rates among minority women and increase survival rates; therefore reducing breast cancer disparities. In this study I will analyze the feasibility of using saliva as a culturally-sensitive biospecimen for breast cancer screening in all women via 1H NMR and surveys. Specifically, I will analyze salivary samples of ethnically diverse women who are either healthy or who have been diagnosed with breast cancer, to identify breast cancer biomarkers.

Entry Number: 2 GL

THE ROLE OF Nkx2-1 IN THE DEVELOPMENT OF THE VENTROMEDIAL HYPOTHALAMUS

By: David Newstrom
Cell and Molecular Biology
Faculty Advisor: Dr. Carmen R. Domingo

Abstract: The homeodomain transcription factor, Nkx2-1, has documented functions in the brain including neuronal migration, differentiation, and patterning. By binding to DNA in a region called the homeobox, these proteins are capable of either activating or repressing gene expression. In this study, I investigated Nkx2-1's role in the development of the ventromedial hypothalamus (VMH). Based on similar studies in the basal ganglia, I propose that a focal deletion of Nkx2-1 in the VMH will result in a defect in differentiation. This work is important, not only in elucidating the regulatory cascades important for hypothalamic development, but also in its broader implications in human obesity, diabetes, and reproductive research. Conditional mutagenesis by Cre loxP was used to delete Nkx2-1 specifically in the VMH using the Steroidogenic Factor 1 (SF1) promoter to drive Cre recombinase. Late markers for VMH characterization were chosen based on physiological function (i.e. Estrogen Receptor 1) while DNA Microarrays identified early genes present in the VMH anlage. These were visualized by immunofluorescent and in situ hybridization staining respectively. I have shown that ER1 expression is severely disrupted while comparatively more subtle phenotypes were observed in the transcription factors Satb2, Fezf1, and Vgll2. Since the gross anatomy of the VMH remained largely intact, these results could suggest a defect in differentiation, but additional confirmatory experiments need to be conducted. These include morphological, projection and migration, electrophysiology, and behavioral assays.

Entry Number: 3 GL

Fic1-DEFICIENT MOUSE AS A MODEL OF CHOLESTATIC DISEASE MBRS-RISE GRANT: R25-GM59298

By: Jacquelynn R. Robinson, Ukina Sanford, and Laura N. Bull
Cell and Molecular Biology
Faculty Advisor: Dr. Frank Bayliss

Abstract: Introduction: Mutations in ATP8B1 (encoding FIC1) result in autosomal-recessive liver disease characterized by intrahepatic cholestasis. Patients with severe FIC1 disease suffer jaundice, itching, fat

malabsorption, growth retardation, and hepatosplenomegaly. Patients display histologic evidence of cholestasis, and serum biochemical features indicative of liver dysfunction and injury, such as abnormal levels of bile acids, cholesterol, bilirubin, alkaline phosphatase (ALP) and transaminases (AST, ALT). Fic1-deficient mice serve as an animal model of FIC1 disease. Previous studies of Fic1-deficient mice have been performed in a 129 strain background where mutant mice displayed a mild form of disease, without histological abnormalities. Recent studies indicate that Fic1-deficient mice in the C57BL/6 (B6) strain manifest a more severe form of liver disease than their 129 strain counterparts, based on biochemical and growth parameters.
Hypothesis: The phenotype of cholestatic disease is milder in mice due to their bile salt pool being less hydrophobic than human patients and their greater capacity to detoxify bile salts. We set out to investigate how we can use the mouse model of FIC1 disease in order to provoke a more chronic manifestation of FIC1 disease by utilizing a longer-term dietary bile salt challenge diet.
Methods: Mice selected for this study were WT and FIC1 G308V/G308V mice in 129S4 strain. Mice were aged >=3 months. Blood was collected prior to administration of a bile acid-supplemented diet. Mice were fed a cholate supplemented diet and challenged for a duration of 6 days short-term (0.5% cholate) or long-term at 12 weeks (0.1% or 0.25% cholate). Weight was monitored during dietary challenge. At sacrifice, mice were weighed; blood, gallbladder bile, liver, intestines, colon, bones and spleen were collected and preserved. Serum parameters (ALP, AST, ALT, bilirubin, and cholesterol) were assayed before and after diet administration. A histologic evaluation of the mice livers was performed using the hematoxylin and eosin (H&E) techniques.
Results: The hepatic features most frequently observed were large liver weight, apoptosis, steatosis, ductular reaction, and regenerative cell activity. These findings are indicative of liver injury, and are consistent with the presence of mild cholestasis. One surprising finding was evident however. Steatosis was observed in WT, and to a lesser extent, in mutant mice. In human FIC1 deficiency patients, steatosis is often present after transplantation suggesting that mice may be modeling post-transplantation cholestatic effects seen in humans.
Discussion / Conclusion: Longer-term cholate feeding triggers greater histologic abnormalities in the Fic1 mutant mice. Currently, we are in the process of testing B6 mice on the longer-term (0.1% cholate) diet. A histologic evaluation of the livers of these mice will be observed using the H & E staining technique. Our findings indicate that B6 background is associated with histologic abnormalities in Fic1-deficient mice. Our data suggests that Fic1-deficient mice in the B6 strain may be a better model of human FIC1 disease than their 129 strain counterparts, and highlights the importance of informed background strain selection for mouse models of liver disease.

Entry Number: 4 GL

ECTODERM CELLS EXPRESS PRIMARY CILIUM AND MECHANOTRANSDUCE CALCIUM AND NITRIC OXIDE SIGNALS

By: Remy Vianney Binder, Seung Jong Lee, and Dr. Wilfred Denetclaw
Cell and Molecular Biology
Faculty Advisor: Dr. Wilfred Denetclaw

Abstract: The ectoderm cell layer in the chicken embryo produces dynamic intracellular free calcium (Ca2+i) and nitric oxide (NO) activities for subsequent NO paracrine signaling into the epithelial cell layers of somites, the segmental plate mesoderm and the dorsal neural tube in embryos. The initiator of the ectoderm Ca2+i and NO signals is unknown but we have shown that the outer-most ectodermal cell layer called the periderm is the first to elevate in both signals. To investigate the periderm, scanning electron microscopy provided an ultra-structural view to show primary cilium in virtually all periderm cells and that the cell junctions are enriched in microvilli and show no gaps between them to compromise their barrier function role. The primary cilium is a solitary non-motile projection from plasma membrane whose function is not fully understood. Previous studies have implicated primary cilia as mechanical or chemical sensors. Because the periderm functions as a barrier and faces the external embryo environment with its primary cilium, its role as a chemical sensor is not likely due to is location away from molecular signals produced within the embryo. Instead, a role as a mechanical sensor is proposed and responsible for inducing the Ca2+i and NO signals in the periderm layer. We tested this by exposing ectoderm to methyl-β-cyclodextrin (MBC) for 6 hours, which we previously showed strongly halted NO signaling. On SEM analysis, ectoderm treated with MBC showed extensive loss of primary cilium and microvilli showing these structures now as small protrusions although cell junctions still remained intact.

The loss of primary cilium, we propose, prevents mechanotransduction for Ca2+i influx and calmodulin binding, a necessary step in the activation of nitric oxide synthase for NO production. The MBC effect also suggests that these cilium structures depend on membrane rafts for structural support and many also contain in them other regulatory factors to mediate mechanotransduction signaling by primary cilium.

Entry Number: 5 GL

REGULAR SPATIO-TEMPORAL PATTERNS IN MULTIPLE PROTEIN FOLDING TRAJECTORIES

By: Saurabh Subodh Gupte
Computer Science
Faculty Advisor: Dr. Hui Yang

Abstract: Proteins are essential part of all living organisms and participate in virtually every process in the cell. In this project, we present an approach to characterize the global structure of a protein molecule based on the local structures identified in the molecule. We derive the local structures as a combination of secondary structures, folding related properties and structural properties of the molecule. As each conformation can have more than one local structure, we associate each conformation with its set of local structures. By representing the sequence of folding frames as a sequence of set of local structures, we identify the Longest Common Subsequence (LCS) between pair of trajectories. We plan to extend this pair-wise LCS to the general case of MLCS by which we can observe the similarity among conformations from any number of different trajectories. To further explore the temporal properties, we propose to use Episode Mining to characterise the spatio-temporal patterns in the structure of the molecule. This would enable us to observe the transitions in the local structures in the folding process. These transitions can enable to get better understanding of the folding process and identify the most common trends in the formation of the protein structure.

Entry Number: 6 GL

DYNAMIC PATTERNS OF ECTODERMAL NO AND Ca2+I LEVELS REGULATE NO SIGNALING ACTIVITIES TO THE PARAXIAL MESODERM FOR MYOGENESIS IN CHICKEN EMBRYOS

By: Seung Jong Lee
Cell and Molecular Biology
Faculty Advisor: Dr. Wilfred Denetclaw

Abstract: Nitric oxide is a messenger gas molecule produced by membrane raft associated nitric oxide synthases: nNOS and eNOS (collectively called cNOS) and signals for cell proliferation, differentiation and apoptosis in the development of embryos. We have previously shown that NO exhibits a 2-step signaling manner in the regulation of somitic myotome formation in 2.5 day-old live chicken embryos. First the outermost ectoderm cell layer, the periderm, increases in NO to rapidly transition across the whole ectoderm layer and then to signal into the subjacent dorsal somite epithelium of somites, segmental plate mesoderm, dorsal neural tube including neural crest cells. However, NO is not elevated in sclerotome mesenchyme or the ventral neural tube. NO also shows a slow dynamic transition in these dorsal epithelial cell layers reminiscent of cell coupling through gap junctions raising the possibility of an intracellular free calcium (Ca2+i) signal similar to NO in these embryonic tissues. To investigate, the highly selective fluorescent indicator probes DAF-2 and Quest Rhod-4 for NO and Ca2+I, respectively, were co-labeled into embryos and monitored by confocal microscopy by time-delay imaging. Embryos at HH14 showed extensive highly patterned NO and Ca2+I signals that mostly colocalized in the ectoderm layer. Caudally, the pattern showed strong bilateral dispersion of these signals at Hensen's node that decreased into lateral cell clusters at more cranial locations along the segmental plate mesoderm. At nascent somite formation areas, the signals were small cell groups that were coincident with each new somite pair. Also, the dorsal neural tube showed strong NO and Ca2+I levels that increased at more cranial locations and merged with similar elevated NO and Ca2+I signals found in ectoderm above the central areas of somites. At somite levels with myotome formation, the NO and Ca2+I signals were very wide spread over the medial somites and dorsal neural tube and appeared to follow the growing epaxial myotome of somites. Interesting, the NO and Ca2+I signal at HH10 embryo stage was very different where these signals were not present over somites and restricted to the cranial half of the embryo at midbrain, hindbrain and dorsal neural tube locations. Furthermore, the stable ectoderm NO and Ca2+i patterns in HH14 embryos could be

disrupted by brief M□CD ectoderm treatments, resulting from loss of membrane rafts. Finally, to determine the order of NO and Ca2+I signaling in ectoderm, 1 mM ATP was added to induce Ca2+I influx via the P2X receptor to show that it precedes the NO signal. BMP4 stimulation was also previously shown to activate NO in the dorsal neural tube, but ectoderm exposure to BMP4 soaked beads failed to raise NO or Ca2+I signals. These results first show that NO signal in the periderm layer is due to cNOS that are contained in membrane rafts. The unique HH10 and HH14 embryo developmental ectoderm NO and Ca2+I patterns suggests that increasing embryo morphogenesis such as during epxial myotome formation places significant stresses on the ectoderm to raise Ca2+I levels that will subsequently enhance ectoderm for NO signaling. We propose a role NO in the development of the myotome due to increased Ca2+I levels in ectoderm.

Entry Number: 7 GL

IDENTIFICATION OF A SECOND SITE SUPPRESSOR OF CDC24 IN SCHIZOSACCHAROMYCES POMBE

By: Shani Chapman
Cell and Molecular Biology
Faculty Advisor: Dr. Sally Pasion

Abstract: Cdc24 protein in Schizosaccharomyces pombe (fission yeast) is a novel protein that is involved in maintaining genome stability. Even though the exact function of this protein is unknown it has been implicated in DNA replication, DNA repair, telomere maintenance and sister chromatid cohesion. At the restrictive temperature, cdc24 cells arrest in S phase, exhibit chromosome breakage and have reduced cell viability. As in other cdc mutants, cdc24 mutants also have an elongated morphological phenotype at the restrictive temperature. We have isolated a genetic suppressor, supx of cdc24 that suppresses the cdc24-G1 temperature sensitive phenotype: in the presence of this suppressor, the mutant cdc24 can form colonies at 34°C. This genetic suppressor also has a morphology phenotype that is distinct from cdc24 at 34°C: supx is not elongated at the restrictive temperature. Further analysis will allow us to characterize the genetic suppressor. Identifying a new genetic interaction will help provide insight into the elusive role of cdc24 in S. pombe.

Entry Number: 8 GL

ECTODERMAL SPHINGOMYELIN IN LIPID RAFTS REGULATE MYOGENESIS IN CHICKEN EMBRYOS IN CONJUNCTION WITH NO SIGNALING

By: Tenzin Bhutia
Cell and Molecular Biology
Faculty Advisor: Dr. Wilfred Denetclaw

Abstract: Ectoderm sphingomyelin is abundantly expressed in the embryo ectoderm layer and is enzymatically processed into several signaling molecules. This strong ectoderm expression of sphingomyelin and its regulated conversion into ceramide and sphingosine1-phosphate leads to the regulated growth and development of paraxial mesoderm through formation of somites and myogenesis in chicken embryos. We propose that this conversion of ectodermal sphingomyelin to its signaling lipids disrupts membrane rafts and affects NO signaling for regulation of myogenesis in chicken embryos. HH14 chicken embryos were treated with bSMase for 6hrs and analyzed for sphingomyelin expression in embryo by lysenin labeling. Lysenin is toxin that binds specifically to sphingomyelin. Normal embryos show lysenin-SM positive cells that are fully labeled or few cells that show punctate labeling. While, embryos treated with bSMase for 6hrs show loss of sphingomyelin expression in ectoderm layer. Embryos treated with bSMase for 6hrs were also subjected to overnight growth of 15-18hrs in humidified incubator and analyzed for myotome formation by titin antibody labeling. Loss of ectodermal sphingomyelin affected primary myotome formation i.e. majority of bSMase treated embryos show complete/partial loss of myotome in somites budded from paraxial mesoderm. This loss of ectodermal sphingomyelin lead to disruption of lipid rafts in ectoderm of chicken embryos. Lipid raft disruption was studied by Cholera Toxin-B labeling of embryos treated with bSMase Vs non treated embryos. Normal embryos show lipid rafts in ectoderm that were labeled with Cholera Toxin-B, while sphingomyelin deprived embryos show no lipid rafts in ectoderm. This loss of sphingomyelin induced lipid raft disruption also correlated with loss of NO signaling. Embryos treated.

Entry Number: 9 GL

GENETIC DISSECTION OF UVB SIGNALING PATHWAYS IN ARABIDOPSIS THALIANA

By: Tyra McCray, Dr. Zeng-Hui He, Hongyun Tong, Xuefeng Sun, Gigi Yen, Huan Jin, Amy Sheldon, Dr. Colin Leasure
Cell and Molecular Biology
Faculty Advisor: Dr. Zheng Hui He

Abstract: Ultraviolet B (UVB), an integral part of sunlight, affects all sun-exposed organisms. Typically high fluence-rate (HF) UVB (> 1.0 mole m-2 s-1) causes cellular damage in plants, whereas low fluence-rate (LF) UVB(<1.0 mole m-2 s-1) may provide important environmental cues for plant growth and development. The damaging effects of HF UVB have been extensively studied, but little is known about the molecular mechanism of how LF UVB serves as a signal to regulate plant growth and development. Understanding the molecular mechanisms of how UVB regulates growth and development is fundamentally important to agriculture and human health. An Arabidopsis root UVB sensitive (rus1) mutant has been identified. rus1 mutants are hypersensitive to very low fluence-rate (VLF) UVB and show developmental arrest when exposed to light that contains as little as 2 nmol m-2 s-1 UVB. More recently, a rus2 mutant that shows identical phenotypes to that of rus1 has also been identified. Our studies showed that RUS1 together with RUS2 function as key regulatory components in UVB responses. The striking phenotypes and extreme UVB sensitivities of rus1/rus2 provide a uniquely feasible platform to identify genetic suppressors that can be good candidates for UVB-specific receptors and signaling components. rus1 seeds were mutagenized and suppressor screens have been carried to identify suppresors of rus (sor) in M2 seedlings. More than 70 sor individuals have been identified so far. We are currently in the process of mapping and cloning these identified sor mutations. Our goal is to fully characterize the functional roles of SORs in UVB responses via various genetic and biochemical approaches. Experiments are currently underway to analyze how sor mutations interact with rus1/rus2 and whether /how SOR proteins physically interact with RUS1/RUS2 proteins.

Entry Number: 10 GL

A NEED FOR NEW THERAPIES TO TREAT MYOCARDIAL INFARCTION THROUGH EXPLORATION OF CARDIOPROTECTIVE ELEMENTS FOUND IN BONE MARROW STEM CELLS AND IL-15

By: Vanessa Aguilera
Cell and Molecular Biology
Faculty Advisor: Dr. Carmen R. Domingo

Abstract: Effective therapies targeting repair of myocardial scarring and restoration of contractile ability have been explored but not perfected using cell therapy. During myocardial infarction (MI), large quantities of cardiomyocytes die due to lack of oxygen and nutrient rich blood, resulting in a myocardial scar. Bone marrow stem cells (BMSC) and their extracts have been shown to reduce infarct size and increase heart function in live mice studies. However, the mechanism behind this phenomena is poorly understood. Identification of cellular factors present in BMSC extracts with anti-apoptotic and cardio-protective properties are of key interest in the search for effective clinical therapies. In addition, IL-15 will be explored for its regenerative properties seen in liver studies. We hypothesize that exogenous BMSC, BMSC lysate and IL-15 contain and trigger cardioprotective qualities that promote cell viability to rescue cardiomyocytes from apoptosis in vitro, through interactions with death receptors and the mitochondria. We aim to indentify which cellular factors promote cell recovery after MI, and understand the role that paracrine factors might have in heart regeneration. Ideally, one protein or a combination of a few proteins will be found effective and reintroduced into in vivo animal experiments. Data generated has important implications in the development of new regenerative therapies in MI patients.

Entry Number: 11 GL

DIET AND FOOD WEBS OF THE CALIFORNIA RED-LEGGED FROG (RANA DRAYTONII)

By: Meghan Bishop
Conservation Biology
Faculty Advisor: Dr. Robert Drewes

Abstract: The California red-legged frog (Rana draytonii) is federally listed as Threatened. Baseline information on diet, prey availability, and food webs of the California red-legged frog is lacking throughout its range. It is hypothesized that California red-legged frogs are indiscriminate feeders and terrestrial food sources in upland habitats are underappreciated. These hypotheses are being tested by conducting stable isotope analyses, analyzing stomach contents flushed from live frogs, and conducting prey availability studies. Preliminary results from diet samples collected suggest earth worms (Oligochaetes) and pacific tree frogs (Pseudacris regilla) are important prey item for the California red-legged frog. Further sampling is needed to construct a food web from stable isotope data. If it is confirmed that terrestrial prey items are an important part of the California red-legged frog diet, land managers may need to put more emphasis on upland habitat protection.

Entry Number: 12 GL

THE EFFECTS OF A NEWLY DISCOVERED PARASITE (APOCEPHALUS BOREALIS) ON THE HEALTH OF HONEY BEE COLONIES

By: Andrew Core, Jonathan Ivers, Chris Quock, Dr. Chris Smith, Travis Siapno, and Dr. John Hafernik
Conservation Biology
Faculty Advisor: Dr. John Hafernik

Abstract: Recent loss of honey bee colonies due to Colony Collapse Disorder (CCD) poses a serious threat to honey bee colonies and many agricultural crops. Honey bees that are affected by CCD abandon their hive, sometimes leaving behind the queen and healthy brood. Recent research suggests that CCD is due to multiple agents. Diseases and parasites have been implicated as playing a central role in CCD (Ratnieks, F. L.W. and Carreck N. L. 2010, vanEngelsdorp, D. and Meixner, M. D. 2009).

Here we investigate a newly discovered parasite of honey bees, the phorid fly Apocephalus borealis. This fly lays its eggs in honey bees. Larvae develop internally and eventually kill their hosts. Parasitized bees seemingly demonstrate the primary behavior that characterizes CCD (abandonment of the hive). Studying honey bees on the San Francisco State University campus, we have recorded rates of infection of up to 90% in stranded bees sampled away from the hive. Bees that are sampled when returning to the hive after foraging have a significantly lower rate of parasitism (5%).

Since A. borealis is broadly distributed in the U.S. it could be an important factor in health of honey bee colonies. We plan to expand our research on this parasite by collecting samples of bees from beekeepers throughout San Francisco Bay Area. We will measure overall health of hives using percent comb cover of adults and brood, and the ratio of adult to brood cover. By comparing the rate of parasitism relative to hive health, we aim to determine if and how infection by this parasite relates to CCD.

Entry Number: 13 GL

BIODIVERSITY AND PHYLOGENY OF MARASMUIS OF NOR YUNGAS, BOLIVIA

By: Brennan Wenck
Ecology and Systematics Biology
Faculty Advisor: Dr. Dennis Desjardin

Abstract: It is estimated that there are approximately 1.5 million different species of fungus in the world, only about 10% of which have been described in scientific literature. Marasmius is a genus of Basidomycota that grows ubiquitously throughout the tropic regions of the world primarily being saprotrophic, consuming the leaf debris that covers the forest floor and largely distinguished by their marcescent nature, they quickly rejuvenate back to life with very little moisture exposure. Dr. Dennis Desjardin and his lab at San Francisco State University has done a fair amount of taxonomic and systematic work on the genus as it occurs in southeast Asia and on several other islands throughout the world, however very little taxonomic work has been done in the neo-tropics of South America, and almost no genetic work has been performed on the genus from this area.

Bolivia is a very unique area to do such work as it has been grossly understudied and more importantly largely undisturbed by human influences. My study looks at a unique region of Bolivia, the Yungas, along the eastern slopes of the Andes that extends from glacier covered mountaintops from well over 20,000 feet down to the Amazonas regions of just over 2,000 feet above sea level. I spent the month of January 2010 collecting several samples from this region in areas far from human impact. My poster will present the collections I made that will help to expand the exploration of Marasmius in this area that can not only be cataloged but can also be compared to similar collections found in other parts of the tropical world.

Entry Number: 14 GL

EFFECTS OF FOREST FRAGMENTATION ON THE PREVALENCE OF BLOOD PARASITES IN BIRDS OF COSTA RICA

By: Holy Archer, Cagan Sekercioglu, and Chase Mendenhall
Ecology and Systematics Biology
Faculty Advisor: Dr. Ravinder Sehgal

Abstract: Using the birds of Costa Rica, we determine how forest fragmentation, landscape mosaics, and the life history characteristics of avian hosts can affect the prevalence of haemosporidian blood parasites. Birds were sampled from 2004-2010 at Las Cruces Biological Station in southern Costa Rica. Habitats include coffee plantations, riparian zones, undisturbed contiguous forest and disturbed forest fragments. Target species include 4 species of manakins, 2 thrush species and the silver-throated tanager. We have collected over 1200 blood samples from these birds. Some of these species are sedentary and others are highly vagile. Preliminary data show prevalences range from 0-55% for Plasmodium and Haemoproteus species. Some of the parasite lineages and their evolutionary relationships are described here for the first time. Interestingly, we find a paucity of parasites in recaptured birds. This study is unique in that avian blood parasites are studied in a single tropical habitat over multiple seasons.

Entry Number: 15 GL

PREVALENCE OF BLOOD PARASITES IN THE AVIFAUNA OF SOCORRO ISLAND , MÉXICO.

By: Jenny Carlson
Ecology and Systematics Biology
Faculty Advisor: Dr. Ravinder Sehgal

Abstract: The Socorro dove (Zenaida graysoni), endemic to Socorro Island , was last reported in the wild in 1972. The Island Endemics Foundation is planning the reintroduction of this species to its former habitat. Recently, the European Breeding Program for this species sent several doves to North America to establish a small population at the Rio Grande Zoo in Albuquerque , New Mexico . This will be the first known attempt to reintroduce a bird species extinct in the wild to its former island range. In order to assess the disease threats the Socorro dove may face, Socorro ground doves (Columbina passerina socorrensis) and mourning doves (Zenaida macroura) of Socorro Island , as well as the Socorro doves in captivity were screened for the avian haemosporidian blood parasites Plasmodium, Haemoproteus and Leucocytozoon. Here we report and compare the evolutionary relationships of haemosporidian blood parasites from birds of Socorro Island , the mainland, and other island populations. We found all three blood parasite genera in the mourning doves and Socorro ground doves, and we discuss the implications for the reintroduction of the Socorro dove. In addition, we study the diversity of mosquito species of Socorro Island . We identified 1) Aedes taeniorhynchus (Wiedeman) and 2) Culex quinquefasciatus (Say); both species are known vectors for avian malaria parasites. These species are not endemic to the island, and therefore they must have been introduced by human activity sometime during the past fifty years.

Entry Number: 16 GL

THE RELATIONSHIP BETWEEN MATERNAL CARE AND EGG CANNIBALISM IN A COLONIAL EARWIG ANISOLABIS MARITIMA (DERMAPTERA: ANISOLABIDIDAE)

By: Julie S. Miller
Ecology and Systematics Biology
Faculty Advisor: Dr. Andrew G. Zink

Abstract: Colonial animals often nest in close proximity, balancing the benefits of aggregation with the costs to their own offspring in terms of threats from conspecifics. Therefore one important function of maternal care in colonial animals may be to protect their own offspring from infanticide or cannibalism by adjacent females. We investigated this hypothesis in the earwig Anisolabis maritima in which females establish solitary subterranean nests in very close proximity to one another. Females remain with their eggs for three weeks, past the time of hatching, and provide maternal care in the form of egg cleaning and egg defense. During this egg guarding period adjacent females are consistently attempting to invade the nest and, when successful, will cannibalize some fraction of a host female's clutch. We conducted removal experiments in both the lab and the field in order to quantify the benefits of maternal care in both a solitary and a colonial context. Our results show that maternal care is essential for the survival of eggs, independent of coloniality, due to the sanitation services that a mother provides. However when conspecifics are present, maternal care also acts to significantly reduce nest invasion and egg cannibalism. Together these results show the multiple benefits of maternal care in earwigs, with the magnitude of these benefits varying across different social contexts.

Entry Number: 17 GL

IS THE PACIFIC CHORUS FROG CARRYING A DEADLY FUNGUS?

By: Natalie Reeder
Ecology and Systematics Biology
Faculty Advisor: Dr. Vance Vredenburg

Abstract: In high alpine lakes of the Sierra Nevada in California the mountain yellow-legged frog is near extinction from infection by a deadly fungus, Batrachochytrium dentrobatidis, or Bd. Bd and the yellow-legged frog are both aquatic so how does Bd spread among populations separated by land? The Pacific chorus frog shares lake habitat with yellow-legged frogs during the summer breeding season but is primarily terrestrial the rest of the year. Healthy chorus frog populations also suggest this species may be resistant to Bd. I use field surveys, laboratory experiments and spatial analyses to answer the following questions: How susceptible is the chorus frog? How much habitat do the two species share? Taking into account reinfection risks associated with the presence of chorus frogs, which lakes might be safe for yellow legged frogs if reintroductions become necessary to save the species?

Entry Number: 18 GL

ROLE OF A PATHOGENIC FUNGUS IN THE DECLINE OF PLETHODONTID SALAMANDERS IN MEXICO AND GUATEMALA

By: Tina Cheng
Ecology and Systematics Biology
Faculty Advisor: Dr. Vance Vredenburg

Abstract: Recent amphibian declines have put approximately one-third of the world's amphibians at risk of extinction, and most recently, a pathogenic chytrid fungus, Batrachochytrium dendrobatidis (Bd), has been implicated in the decline of over 200 amphibian species worldwide. This newly emerged infectious disease was first reported in 1998 and has since been found on every continent except Antarctica. My research focuses on the possible role that Bd may have played in the decline of plethodontid salamander populations in México and Guatemala during the late 1970s and early 1980s. Through lab and field investigation, I explore the virulence of this disease to plethodontid salamanders as well as its threat to wild populations. Results, conclusions, and future directions to this study are presented in this poster.

Entry Number: 19 GL

CHARACTERIZING ECDYSIS BEHAVIOR IN THE STICK INSECT, CARAUSIUS MOROSUS

By: Andrew Carriman
Physiology and Behavioral Biology
Faculty Advisor: Dr. Megumi Fuse

Abstract: Ecdysis, or the shedding of the cuticle, is a process common to all insects to facilitate growth and development. It is often under circadian control. Ecdysis has been best studied in holometabalous organisms, which undergo complete metamorphosis. Ecdysis in the stick insect, Carausius morosus, a hemimetabalous insect undergoing incomplete metamorphosis, has not been characterized. Our goal is to determine if the ecdysis neural network is conserved between hemimetabolous and holometabolous insects, by a) Determining whether ecdysis in the stick insect is governed by a circadian rhythm; b) Determining whether the same ecdysis regulatory hormones of the central nervous system (CNS) found in holometabalous insects are conserved in the stick insect; c) Describing ecdysis behaviors in the stick insect. C. morosus was housed in regulated light/dark cycles and checked twice daily for ecdysis. The expression of compounds involved in ecdysis, namely cGMP, leucokinin and eclosion hormone, were assessed in the stick insect CNS by immunohistochemistry, and compared to known expression patterns in the hornworm, Manduca sexta. Ecdysis behaviors were videotaped and characterized. We found that a) ecdysis in the stick insect occurred just before early "dawn"; b) only cGMP and leucokinin were apparent in the CNS of both insects, and c) many classic ecdysis behaviors were observed in the stick insect. A simple model such as Carausius may help elucidate some mechanisms of circadian control, but also aid in developing environmentally-friendly pesticides.

Entry Number: 20 GL

EFFECTS OF FOOD AVAILABILITY ON NEUROGENESIS IN THE TOBACCO HORNWORM, MANDUCA SEXTA

By: Anita Yip
Physiology and Behavioral Biology
Faculty Advisor: Dr. Chris Moffatt

Abstract: The development and function of the CNS depends on the interplay between the growth and death of neurons in relationship to organism's age and the prevailing environmental conditions. Many organisms live in environments where they are subjected to different food or nutrient availability, which could be deleterious to the development of the CNS if physiological mechanisms were not present to accommodate these fluctuations. To determine how food availability affects neurogenesis (NG), larval M. sexta will be subjected to various food restrictions and rate of NG in their nerve cords quantified using BrdU via ICC. We anticipate that larva subjected to the low food availability will have decreased NG. These results have future implications for studying the mechanisms through which the nervous system is able to maintain normal patterns of development despite potentially disruptive variations in the environment.

Entry Number: 21 GL

ADENOSINE REGULATES DEVELOPMENT DURING TISSUE REPAIR

By: Cleopa Omondi, Sayed Miry, and Louie Vermos
Physiology and Behavioral Biology
Faculty Advisor: Dr. Megumi Fuse

Abstract: Insect imaginal discs are structures in immature insects that will grow into adult structures such as the wings and antennae. When injured, they show a remarkable capacity to regenerate, resulting in healthy adult structures. During regeneration, however, development is delayed by what appears to be a blood-borne factor, to allow time for tissue repair. This has been shown in the fruitfly, Drosophila melanogaster, as well as the larger hornworm, Manduca sexta, after tissue injury induced genetically or by x-ray irradiation. This study looked at the role that adenosine has in delaying development in M. sexta. Adenosine has been implicated in developmental regulation, but not specifically during tissue repair, in D. melanogaster. Studies using the larger M. sexta may yield more insight into adenosine's role as a hormonal signal in delaying pupation to allow for tissue repair. A total of 80 larvae of this moth were injected with 10-5 M, 10-6 M, or 10-7 M adenosine in a saline vehicle, then timed for pupation and eclosion to the adult. This data was compared with uninjected and

saline-injected control groups as well as x-irradiated insects (to induce tissue damage). Analysis confirmed that adenosine delayed pupation in a dose-dependent matter. The confirmation of adenosine's role as a developmental delay-inducing hormone is a breakthrough in characterizing the overall hormonal signaling cascade in response to tissue injury. Adenosine's presence in the blood of injured insects must be confirmed in the future.

Entry Number: 22 GL

CHARACTERIZING CGMP REGULATION DURING ECDYSIS IN MANDUCA SEXTA

By: Sabina Bera and Jared Geibig
Physiology and Behavioral Biology
Faculty Advisor: Dr. Megumi Fuse

Abstract: Through investigating behaviors in a simpler model we can better tackle elaborate pathways in more complex species. One such model known as ecdysis (the process of arthropods shedding their cuticle) is perfect for understanding the communication between neurons. Manduca sexta, the tobacco hornworm, provides easily identifiable behavioral traits, making it ideal for studying ecdysis. The hormonal pathway to execute ecdysis is still a working model with many gaps in knowledge. For example, the cause for cGMP (a common secondary messenger) release is essential to the understanding of the pathway. cGMP has been previously shown to play a role in ecdysis. However, the source of cGMP up-regulation has yet to be identified. Previous research suggests eclosion hormone (EH) is responsible for this up-regulation. The aim of this project was to remove the source of EH (located in the brain) and to observe the resulting cGMP levels. It was concluded that removal of the brain results in little to no presence of cGMP during later time periods. Results suggested that EH from the brain is needed to sustain cGMP for a prolonged time period, but may not be the direct cause of cGMP up-regulation.

Entry Number: 23 GL

CONFIRMATION OF DICISTRONIC GENE STRUCTURES IN SEVERAL DROSOPHILID SPECIES

By: Henry Hunter
Cell and Molecular Biology
Faculty Advisor: Dr. Chris Smith

Abstract: Encoding multiple genes in a single messenger RNA (mRNA) is a strategy common among prokaryotes and viruses, but not eukaryotic cells. While di- or multi-cistronic genes were once thought to be non-existent in eukaryotes, they have now been observed in the genomes of a number of species, including humans. High-quality genomic annotation of Drosophila melanogaster (fruit fly) has revealed over 100 dicistronic genes, where two non-overlapping genes are expressed from a single mRNA transcript. The mechanisms that mediate dicistronic expression in eukaryotes are poorly described, but evidence has shown that RNA structures in the mRNA play a role in regulation. Interestingly, these same genes often appear as standard monocistronic transcripts in some distantly related species, suggesting that there exist mechanisms that allow genes to merge and become expressed as dicistronic products. Recently, 11 other Drosophilid genomes have been completed, providing an excellent system to study the structure of dicistronic genes over evolutionary time. While full-length cDNA evidence supports the existence of these genes in D. melanogaster, to date there has been no direct evidence that these genes are also dicistronic in other species. We identified and annotated orthologs of several D. melanogaster dicistronic genes and their putative gene structures in multiple Drosophilid species. We used these annotations to develop PCR primers to confirm the existence of each dicistronic transcript in cDNA samples. RT-PCR cDNAs were sequenced and compared to verified dicistronic genes to identify gene structural changes over evolution. These results are useful to refine existing dicistronic gene annotations, aid in discovering how dicistronic genes function in eukaryotes, and provide a detailed comparative system to study the forces that shape the evolution of gene structures over evolutionary time.

Entry Number: 24 GL

GLOBAL ANALYSIS OF HISTONE SUBTYPE COMPOSITION IN C. ELEGANS SPERM USING MudPIT MASS SPECTROMETRIC ANALYSIS

By: Michael Yee
Cell and Molecular Biology
Faculty Advisor: Dr. Diana Chu

Abstract: To investigate C. elegans sperm chromatin composition, specificalli with histone H2A, we conducted a global analysis of sperm and embryonic chromatin proteins using Multidimensional Protein Identification Technology (MudPIT) mass spectroscopy, Western Blot analysis, and immunofluorescent microscopy. We find that the modification profile differs greatly between sperm and embryo, suggesting that chromatin undergo3es extensive epigenetic reprogramming during spermatogenesis. Thus, our work provides unique insight about cell type-specific differences in chromatin composition and modification, and how sperm can contribute epigenetic information to the embryo.

Entry Number: 25 GL

MOLECULAR BASIS FOR HOST SPECIFICITY IN AVIAN MALARIA

By: Criseyda Martinez
Microbiology
Faculty Advisor: Dr. Ravinder Sehgal

Abstract: Malaria is a disease that infects multiple organisms: humans, chimpanzees, reptiles and birds. Malaria is caused by Plasmodium blood parasites and has dramatically affected bird populations. The extinction of several avian populations in the Hawaiian Islands was due to a newly introduced Plasmodium strain that was able to infect multiple bird species (generalist parasite). Host-specific parasites (specialists) can infect only one bird species. Previous work has shown that specialists can become generalists in host switching events, making them more virulent. The molecular basis of host specificity in avian Plasmodium parasites is unknown, but our project aims at identifying genes responsible for host specificity. Previous data has implicated the erythrocyte binding-like (ebl) genes in human and chimpanzee Plasmodium strains as potential host-specific determinants. Our studies will focuses on identifying the ebl genes in avian Plasmodium strains infecting African rainforest birds by using PCR to amplify these genes. Currently we have acquired a genetic region for a putative candidate ebl gene in Plamodium gallinaceum, an avian strain. We further seek to sequence the genes and analyze their DNA and amino acid sequence to determine whether sequence variability correlates with host specificity. We will plan to map the distribution of ebl gene alleles of African rainforest birds. We expect to identify the ebl family of genes in avian malaria and correlate them to host-specificity. The identification of ebl genes in avian parasites characterized in this study will allow us to predict potential emerging diseases in avian populations. Predicting potential host-switching events could allow us to slow down the spread of malaria.

Entry Number: 26 GL

GENOMIC ANALYSIS OF THE AMMONIA OXIDIZING ARCHAEON NITROSOCALDUS YELLOWSTONII HL72

By: Hope M. Gray, N. Pinel, M.N. Ashby, C.B. Walker, H. Urakawa, C.W. Schadt, L. Sayavedra-Soto, and D.A. Stahl
Microbiology
Faculty Advisor: Dr. Jose R de la Torre

Abstract: Ammonia-oxidizing archaea (AOA) are a recently discovered group of microorganisms with an important role in global nitrogen cycling. We have sequenced the genome of Nitrosocaldus yellowstonii strain HL72, a thermophilic AOA, and are using this data to infer N. yellowstonii's evolutionary history, metabolic pathways, and potential physiological capabilities.

Entry Number: 27 GL

HPV

By: Marilyn Walton and Devi Paulvannan

Microbiology

Faculty Advisor: Dr. Lily Chen

Abstract: Study of information of HPV and best way to present to target audience

Entry Number: 28 GL

CD8+ CELL NONCYTOTOXIC ANTIVIRAL RESPONSE SUPPRESSES HIV-1 TRANSCRIPTION IN PRIMARY MONOCYTE-DERIVED-MACROPHAGES

By: Michelle Wray

Microbiology

Faculty Advisor: Dr. Jay Levy and Dr. Frank Bayliss

Abstract: CD8+ T cells can suppress viral replication in infected CD4+ T cells through the CD8+ T lymphocyte non-cytotoxic antiviral response (CNAR). CNAR is mediated by a soluble factor, CD8+ cell antiviral factor (CAF), which blocks viral transcription. b-chemokines can suppress replication of certain strains of HIV-1 by competing with the virus for the CCR5 co-receptor. CD8+ T cells are known to produce b-chemokines. Treatment of HIV-1 infected cells with neutralizing antibodies (nAbs) against b-chemokines, when cocultured with CD8+ T cells, does not markedly affect virus suppression. This finding supports that there is another factor produced by CD8+ T cells, that inhibits virus replication.

The effect of CD8+ cells on viral replication in HIV-infected macrophages is being assessed. To investigate CNAR in HIV-1 infected macrophages, transwell assays are performed using a nAbs treatment, and viral replication is measured. RT-PCR will be performed to determine if CNAR in macrophages functions as a block in transcription from the integrated provirus.

Macrophages are important in transmission and pathogenesis of HIV. Macrophages are thought to be important in the establishment of a latent infection. A better understanding of CNAR in the context of infected macrophages could lead to the development of immune-based therapies for treatment of HIV-infected individuals.

Entry Number: 29 GL

INHIBITION OF NITRIFICATION IN AMMONIA-OXIDIZING ARCHAEA

By: Sandra Melloy

Microbiology

Faculty Advisor: Dr. Jose de la Torre

Abstract: In recent years it has become increasingly apparent that ammonia-oxidizing archaea (AOA) contribute significantly to global nitrogen cycling.B Although well studied in ammonia-oxidizing bacteria (AOB) such as Nitrosomonas europaea, there are no published reports to date on the effect of the inhibitors allylthiourea (ATU) and nitrapyrin on ammonia oxidation in AOA. The objective of this study is to quantify the responses ofB AOA to known inhibitors of ammonia oxidation. For these studies, we use the recently described thermophilic AOA, Nitrosocaldus yellowstonii HL72. Using measurements of nitrite production we report significant differences in the response of HL72 B to known inhibitors than those observed by AOB in previous studies. For example, HL72 was unaffected by 10 ΞOM ATU and complete inhibition was only observed at concentrations of ATU above 1 mM. In contrast, HL72 was uninhibited by nitrapyrin due to its thermal instability. Our findings suggest that compounds such as ATU may be important for in situ rates partitioning. Nitrapyrin, on the other hand, is not an appropriate tool for rates partitioning in thermophilic systems due to its thermal instability.

Entry Number: 30 GL

THE ROLE OF THE C42-C58 DISULFIDE BRIDGE IN A CATALYTICALLY ACTIVE THREONINE PROTEASE VARIANT BY MOLECULAR DYNAMICS SIMULATION.

By: Trevor Gokey

CCLS

Faculty Advisor: Dr. Anton Guliaev

Abstract: Serine proteases play an important role in the regulation of most biological processes. Malfunctions in this class of enzyme lead to a variety of diseases and thus are an important target in medicinal chemistry. Trypsin is a digestive proteinase which cleaves peptide bonds at the carboxyl side of lysine or arginine via the conserved catalytic triad (Ser 195, His 57, and Asp 102) which is characteristic of serine proteases. It also contains a highly conserved disulfide bridge (C42 – C58) near the catalytic triad. Previously, by using enzymatic assays, it has been shown that replacing serine with threonine (S195T variant) results in a significant loss of activity. However, it was found that removing the nearby disulfide bridge in the S195T variant (C42A C58A S195T; AA-Th variant) returns activity to more than half that of wild type. In our work using AMBER, a molecular dynamics simulation package, we provided structural rationale to the differences in enzymatic activity for two variants (S195T and AA-Th) as compared to wild type. >From our results, the key component to the activity of the protease was the conformation of the hydroxly group of threonine. Steric constraint imposed by the disulfide bridge prevented the hydroxly group from occupying the area necessary for catalysis. In addition, the methyl moiety of T195 should interfere with the carbonyl group of an incoming substrate. This conformation of the hydroxly group in the S195T variant was consistently different to wild type and the AA-Th variant. In the AA-Th variant, as observed by the long range MD simulations, the lack of the disulfide bridge increased the conformational flexibility of threonine residue and allowed the hydroxly group to be in the catalytically active orientation.

Entry Number: 31 GL

HYDROLYSIS OF a-HALO AND a-CYANO PYRIDINIUM: A MODEL FOR OROTIDINE 5'-MONOPHOSPHATE DECARBOXYLASE (OMP DECARBOXYLASE)

By: Sha Huang
Biochemistry
Faculty Advisor: Dr. Weiming Wu

Abstract: The α-halide and α-cyano groups on the pyridinium ring were found to undergo facile substitution in buffer solution to produce corresponding 2-pyridones. On the other hand, the reaction of 6-chloro-1,3-dimethyluracil was very sluggish. The greatly enhanced rates found with pyridinium compounds have indicated a possible source of the rate acceleration seen in the substitution of 6-cyanouridine 5'-monophosphate catalyzed by orotidine 5'-monophosphate decarboxylase.

Entry Number: 32 GL

S-NITROSYLATION OF SOLUBLE GUANYLATE CYCLASE

By: Kensuke Yamamoto, Jasmin Kristianto, and Stephanie Wood
Biochemistry
Faculty Advisor: Dr. Nancy Counts Gerber

Abstract: Soluble guanlyate cyclase (sGC) catalyzes the conversion of GTP to cGMP, a secondary messenger that binds to down stream cGMP-dependent regulators that involve in diverse physiological events such as vasodilatation and immunomodulation. Upon binding nitric oxide (NO), the basal activity of sGC increases several hundred fold. The presence of the NO can also result in a posttranslational modification called S-nitrosylation that has been identified as being physiologically significant to some proteins. S-nitrosylation of sGC has been identified in vivo and has been proposed to be important in it regulation. Due to the instability of S-nitrosothiols, a biotin-switch method has been developed to identify S-nitrosylated proteins. The purpose of this study is to find out the effect that S-nitrosylation has on the activity of sGC, and identify the location of the posttranslational modification site(s). This will allow us to study the effect the modifications have on the structure and activation of sGC by NO and other activators.

Entry Number: 33 GL

EFFECT OF THE HEME POCKET ENVIRONMENT ON THE NITRITE REDUCTASE ACTIVITY OF SW MYOGLOBIN

By: Lea Lough, Kay Saw, Benjamin Lintner, and Ignacio López-Peña
Biochemistry
Faculty Advisor: Dr. Raymond Esquerra

Abstract: Deoxygenated hemoglobin in red blood cells supports vasodilatation during hypoxia by converting nitrite (NO_2^-) to nitric oxide (NO) (1). The nitrite reductase activity of heme proteins has been shown to play essential roles in physiology. It was shown that the nitrite reductase activity of myoglobin is essential for protecting the heart from myocardial infarction during ischemia (2). To better understand how the protein matrix controls the nitrite reductase chemistry of the heme active site, we compared the nitrite reductase activity of several myoglobin (Mb) distal pocket mutants. We hypothesize that the distal histidine (H64) plays an essential role in converting nitrite to nitric oxide by acting as a proton donor or stabilizing the protonated HNO species (Scheme 1). To test this hypothesis we measured the nitrite reductase activity of several mutants lacking the distal histidine (H64A, H64Q, H64V, and H64L). The pseudo-first order bimolecular rate constants of these distal histidine mutants (Table 1) indicate that the nitrite reductase chemistry of these mutants is slower than wild-type Mb. These results indicate that the distal histidine facilitates the chemistry but is not essential. We also hypothesize that the rate of the reaction will be limited by the size of the distal pocket, as a smaller pocket will reduce accessibility of nitrite to the heme. We made L29F and L29W distal pocket mutants which is known to reduce the size of the distal pocket. The bimolecular rate constant of the L29F is unchanged and the L29W is about 25 times slower than the rate for wild-type Mb. The distal pocket volume does slow the chemistry but its effect is not as important as the the polarity of the H64 residue. Understanding how the protein matrix controls the nitrite reductase chemistry of heme proteins is essential toward understanding how these proteins generate NO physiologically, and in designing therapeutics based on the nitrite reductase activity of heme proteins.

Entry Number: 34 GL

THE SIGNIFICANCE OF SECOND SHELL INTERACTION IN SERINE PROTEASE

By: Lei Zhang
Biochemistry
Faculty Advisor: Dr. Teaster Baird, Jr

Abstract: In Trypsin, the hydrogen bond between Lys60 and Tyr39 and the hydrophobic interaction between Lys60 and Phe41 appear to fix the position of Phe41 backbone carbonyl oxygen to specifically accept the hydrogen bond from the amide hydrogen of trypsin inhibitor ecotin, which is a serine protease inhibitor from E.Coli. Similar interactions between trypsin and other trypsin macromolecular inhibitors are observed and these interactions suggest substrates may interact with trypsin in this position similarly. The S1â€™ sub-site of trypsin which is â€œthe first shellâ€ for binding substrates consists of Phe41, His57 and Cys42â€”Cys58 disulfide bond. The residue Lys60 which is near S1â€™ pocket and Tyr39 constitute a â€œsecond shellâ€ of trypsin. The research will use the classic serine protease trypsin as a model system to investigate the relationship between two second shell residues and their interaction with the first shell residue Phe41 by substituting Lys60 with small hydrophobic residues Ala and Val. Such substitutions are expected to alter the catalytic properties of the enzyme by relaxing the conformational restriction on Phe41.

Entry Number: 35 GL

REFINING THE CATALYTIC MACHINERY OF AN ENGINEERED THREONINE PROTEASE BY SITE-DIRECTED MUTAGENESIS

By: Mie A. Lansang
Biochemistry
Faculty Advisor: Dr. Teaster Baird, Jr.

Abstract: In nature, threonine proteases are rarely found and one of the few example is a multiunit protein complex, proteosome, that degrades the damaged proteins and peptides by proteolysis. Substituting Ser-195 of trypsin to Thr-195 demonstrated the loss of activity despite of the similar chemical reactivity of threonine side chain to that of serine. In this study, the Cys-42-Cys-58 disulfide bridge of S195T trypsin was replaced with

two valine residues to increase threonine protease activity and to understand the structural limitations and requirements of this subsite with respect to catalysis. The activities of C42V/C58V and C42V/C58V/S195T trypsins (VV-Tn and VVT-Tn, respectively) were evaluated with benzyloxycarbonyl-Gly-Pro-Arg (Z-GPR) p-nitroanilide (pNA) and 7-amino 4-methyl coumarin (AMC) substrates. VVT-Tn was 150 and 10 times more active towards the pNA and AMC substrates, respectively, than C42A/C58V/S195T trypsin (AVT-Tn; kcat/KM values). In a thermostability study, both variants and WT trypsin retained > 80% of their activity suggesting that the substitutions did not destabilize the enzymes. The pH dependence of activity profiles were identical to WT trypsin, suggesting that any structural differences do not perturb the pKas of catalytically relevant residues. Finally, the KI of p-aminobenzamidine was identical for native and VV-Tn but that of VVT-Tn was half the KI for WT. Therefore, Thr-195 may affect the primary binding pocket structure. Collectively, these results indicate that the activity of Thr-195 trypsin variants may be increased by appropriate substitutions at positions 42 and 58. However, the structural perturbations induced by these substitutions make achievement of wild-type levels of activity less likely.

Entry Number: 36 GL

BIOCHEMICAL CHARACTERIZATION OF STYRENE OXIDE ISOMERASE FROM PSEUDOMONAS PUTIDA S12

By: Sindy Liao
Biochemistry
Faculty Advisor: Dr. George Gassner

Abstract: Styrene is an important chemical in the petroleum industry where it is used to make plastic, insulators, and rubber-based products. Unfortunately, styrene has been identified as a suspect carcinogen and its use has lead to environmental pollution. Pseudomonas putida S12 is capable of metabolizing styrene as a source of carbon and energy. The first step of the metabolism of styrene by a two-component flavoprotein monooxygenase yields styrene oxide (SO), a reactive alkylating agent and carcinogen, which is then isomerized to phenylacetaldehyde (PAL), a less toxic intermediate, by an enzyme called styrene oxide isomerase (SOI). The phenylacetaldehyde produced is then oxidized to phenylacetic acid (PAA) by an NAD+ dependent phenylacetaldehyde dehydrogenase (PADH). The goal of this research is to understand the kinetic and structural mechanism of SOI in the styrene degradation pathway.

Entry Number: 37 GL

CONFORMATIONAL STUDIES OF SOLUBLE GUANYLATE CYCLASE USING TIME-RESOLVED FLUOROMETRY

By: Stephanie M. Wood
Biochemistry
Faculty Advisor: Dr. Nancy Counts Gerber

Abstract: We have used time-resolved fluorometry to investigate the decay lifetimes of the four tryptophans in soluble guanylate cyclase (sGC). sGC is a heme sensor protein, which is able to be physiologically activated by nitric oxide (NO). Based on our lab's previous work, the binding of NO induces a conformational change, thus activating sGC. Based on this work, a model has been created using steady-state conditions. We are using the time-resolved data, a more sensitive technique to confirm the steady-state model. Unfortunately the individual tryptophan's do not have unique lifetimes. Since all the tryptophan's produce three similar lifetimes, we have to look at the changes to the lifetimes on a global scale. We are using quenching studies to see the differences between the different protein conformations. The wild-type protein can be quenching with 2 M KI indicating exposure of the tryptophans. When we add NO to the wild-type protein, we can no longer quench the protein, indicating that the tryptophans are no longer accessible. The wildtype protein with CO bound provides a more complicated mechanism still being investigated.

Entry Number: 38 GL

EXPLORING INDIRECT HYDROPHOBIC INTERACTIONS IN TRYPSIN

By: Raniel R. Alcantara
Cell and Molecular Biology
Faculty Advisor: Dr. Teaster Baird, Jr.

Abstract: Trypsin is a well-characterized protease which is found in most animals. Trypsin has a broad specificity, cleaving C-terminal to either arginine or lysine. Specific point mutations to the area next to the catalytic triad, the S1' pocket, can introduce increased specificity to trypsin. Crystal structures of trypsin with various macromolecular inhibitors show that Phenylalanine 41 of the S1' pocket is kept in a bent angle by a cage formed with Tyrosine39 and Lysine60, and its carbonyl oxygen is within hydrogen bonding distance to the P2' amide hydrogen of the inhibitor. Introduction of specific point mutations into the 41 position may help determine if this interaction is important in substrate or inhibitor binding. Phenylalanine was substituted with several hydrophobic amino acids valine, isoleucine and leucine, and each variant trypsin was then be initially characterized using the substrate Z-Gly-Pro-Arg-pNA. All three variants were significantly less active than wild type. It is hypothesized that this loss in activity may be caused by movement of the backbone atoms of the substituted amino acid which is then propagated to the catalytic triad.

Entry Number: 39 GL

LOW-TEMPERATURE FABRICATION OF ANATASE FILMS WITH TUNABLE THICKNESS AND MORPHOLOGY

By: Shirin M. Usmani and Diana Mars
Chemistry
Faculty Advisor: Dr. Andrew S. Ichimura

Abstract: Titanium dioxide finds extensive environmental applications in oxidative photocatalysis and dye-sensitized solar cells. Applications such as hybrid solar cells utilize thin films of titanium dioxide as the electron transport material. Typically, the films are prepared from TiO2 nanoparticle containing sols that are spin-coated onto substrates and subsequently sintered to induce interparticle contact. We have pursued an economical strategy of thin film fabrication that involves low-temperature growth of crystalline anatase directly onto a functionalized surface from homogeneous solutions. In this approach, a densely packed functionalized self-assembled monolayer (SAM) with a terminal Ti-OH functional group is used to chemically bond the film to the underlying gold substrate. We have designed films with tunable thickness and morphology on both mica and silicon wafers. The growth of films is found to be a function of pH, concentration of fluoride, and temperature. Surface science studies were conducted using FTIR, Ellipsometry, HR-SEM, and X-ray Diffraction. It was found that novel combination of pH and temperature promotes ordered growth of titania films.

Entry Number: 40 GL

REMEDIATION OF NITROAROMATIC POLLUTANTS BY REDUCTION AND SURFACE ADSORPTION

By: Yogita Patil
Chemistry
Faculty Advisor: Dr. Bruce Manning

Abstract: The use of zero valent iron (Fe0) as an effective reducing agent for nitroaromatic compounds (NACs) was investigated in this study. The reaction of 3-nitrotoluene (3-NT) with 100 mesh Fe0 powder was analyzed with different analytical techniques in pH 6.5 aqueous buffer under aerobic, stirred conditions. Results from high performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GC-MS) analysis showed that the major transformation of 3-NT is the reduction of nitro group (NO2) to the corresponding amine (NH2) with some minor byproducts. The reaction is rapid with 50% removal of 15 ppm 3-NT removed and transformed to byproducts in 3 minutes by 2 grams of Fe0 powder. In addition the reaction follows first-order rate law kinetics over the early reaction period (0-3 min) where the rate of reaction depends on the concentration of the analyte. It is observed that the relative rate of reaction (ln(C/C0) vs. time) rapidly decreases at higher analyte concentration. It has been found that the removal of NAC contaminants can be improved by improving the iron surface area availability for reduction and adsorption of NACs. Nanoparticle

zerovalent iron is used in this analysis as the next step and is proved to be very efficient in the reduction of NACs. The phenomenon of reduction by surface adsorption which leads to oxidation of iron forming iron oxide (FeOx), hematite (a-Fe2O3) and magnetite (Fe3O4) are studied with scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS).

Entry Number: 41 GP

CLOUD COMPUTING FOR DATA INTENSIVE APPLICATION

By: Jinesh Lalan
Computer Science
Faculty Advisors: Dr. Dragutin Petkovic, Mike Wong, and Dr. Ljubomir Buturovic

Abstract: Research in molecular biology, such as genomics and proteomics, involves the analysis of huge amounts of data. To interpret this massive amount of data, biologists encounter computational challenges of scale and infrastructure demands. Usually, once an application is deployed it is bound to a particular infrastructure until it is upgraded. The result is low efficiency, utilization and flexibility. One of the solutions for overcoming these challenges is performing these large computations on a cloud computing system such as the Amazon Elastic Cloud Compute (EC2). Here we pilot a sample bio-informatics application and analyse overall ease of use, efficiency and cost-effectiveness of cloud systems specifically Amazon EC2. Such a study shall help us decide the feasibility of running data intensive research applications on cloud

Entry Number: 42 GP

THREE DIMENSIONAL RECONSTRUCTION OF KNOTS AND KNOTTED PARTICLES

By: John Collins
Computer Science
Faculty Advisor: Dr. Javier Arsuaga

Abstract: Single Particle Reconstructions are commonly used to elucidate structures of different types of small particles with precision approaching that of x-ray techniques. Such reconstructions assume a homogeneity of data or a small heterogeneous collection of homogeneous subgroups. Current models of the packing of small capsid viruses like bacteriophages suggest a spooling type model with some nonuniformity resulting in small numbers of knots. Three dimensional reconstructions have been used to justify different models[1] but such assumptions assuming uniform homogeneity of a data set disregard slight variations which could be present. We present a look at the single particle reconstruction process as a whole as well as a view of two different sets of data. We ask, “what happens if single particle reconstruction is used to reconstruct a single model from a data set in which each particle is very similar but no two are exactly alike?”

Entry Number: 43 GP

EFFICIENT FINITE DIFFERENCE-BASED SOUND SYNTHESIS USING GPUS

By: Marc Sosnick
Computer Science
Faculty Advisor: Dr. Bill Hsu

Abstract: Finite Difference (FD) methods can be the basis for physics-based music instrument models that generate realistic audio output. However, such methods are compute-intensive; large simulations cannot run in real time on current CPUs. Many current systems now include powerful Graphics Processing Units (GPUs), which are a good fit for FD methods. We describe an implementation of an FD-based simulation of a two-dimensional membrane that runs efficiently on mid-range GPUs; this will form a framework for constructing a variety of realistic software percussion instruments. For selected problem sizes, real-time sound generation was demonstrated on a mid-range test system, with speedups of up to 2.9 over pure CPU execution.

Entry Number: 44 GP

IMPROVING FEATURE: ACADEMIC BIOINFORMATICS SOFTWARE FOR STANFORD UNIVERSITY

By: Pracheer Sehrawat, Gemma Lee Fu-Sun, Mandar Modgi, Trevor Blackstone, and Gurgen Tumanyan
Computer Science

Faculty Advisors: Dr. Dragutin Petkovic, Dr. Russ Altman, and Mike Wong
Abstract: FEATURE is a software suite developed by the Helix Group at Stanford University. Its primary purpose is to characterize the biological functions of unknown protein sites by comparing them to observed functional sites on known proteins. The software was initially developed by researchers at Stanford University, and is available for use by students, researchers, and the bioinformatics community. Using the best modern software engineering practices, we are improving FEATURE in terms of usability, maintenance, and future development. This includes code
refactoring, API design, testing, auditing, and web UI design, while utilizing the full software development life cycle. This project is supported by an NIH grant awarded to the Stanford University Bioengineering Department, led by Prof. Russ Altman, who has contracted this work to the FEATURE software engineering team at SFSU.

Entry Number: 45 GP
AUTOMATIC LESSON PLANNER
By: Tingting Sun
Computer Science
Faculty Advisors: Dr. Kaz Okada and Dr. Susan Courey
Abstract: The Automatic Lesson Planner is designed as an online teaching system to assist the faculty and students in Special Education Department at SFSU. It aims to provide a user friendly and intelligent tool for users to create evidence-based teaching strategies effectively, i.e. the function to search appropriate peer-reviewed articles in SFSU library database via the keywords list. The design of the Automatic Lesson Planner follows software engineering and data mining methodology and adopts an incremental approach for easily integrating additional functions or features into the system.

Entry Number: 46 GP
MACHINE LEARNING BASED MEDICAL IMAGE REGISTRATION
By: Yang Zhao
Computer Science
Faculty Advisor: Dr. Kaz Okada
Abstract: This thesis proposed a machine learning based feature selection solution for medical image registration. Image registration is a process of transforming different sets of data obtained from different measurements into one coordinate system for comparison or integration. In our solution, machine learning technique was used to train feature detectors in a cross validation process within our 3D CT scan training dataset. The feature detectors with high cross validation score were then selected and used upon our 3D CT scan testing data set to do image registration. Furthermore, quantitative evaluation of proposed method is performed in the context of feature selection and medical image registration. Results of quantitative experiments suggest that performance improvement in both accuracy and stability has been achieved by introducing proposed machine learning based feature selection method.

Entry Number: 47 GP
a-TAT (ELECTRONIC TEAMWORK ASSESSMENT TOOL)
By: Gurdeep Singh, Sanket Parab, Ravi Soni, and Srijita Shrestha
Computer Science
Faculty Advisors: Dr. Dragutin Petkovic, James Wong, and Gary Thompson
Abstract: eTAT is an innovative Electronic Teamwork Assessment Tool pioneered at SFSU. It measures collaboration and cooperation within a team undertaking software engineering projects. It is a web based application whose target users are the instructors of academic organizations and institutions. The basic idea is to measure team member's collaboration and communication through data collected by recording instructor's annotations and student's level of participation in various collaborative activities. The data collected through above mentioned activities is then displayed to user (instructor) using textual, tabular and graphical (charts and graphs) format. This representation of data in various formats facilitates teamwork measurement.

The application will interface with the online open-source software development hosting platform Google Code Projects. Our software will collect data from Kenai in the form of RSS Feeds, web hooks and Google APIs. Data will be collected through instructor's annotations and from student's activities on Mailing lists, Discussion forums, Surveys, Issue tracking and code commits to the project repository, while they work together on a project The collected data will be stored in centrally administered database and then displayed to instructor in textual, tabular or graphical format so as to enhance visualization and make it easy to understand and compare. This rendering will enhance the instructor's ability to assess teamwork, collaboration and communication effectively and easily.
Survey feature is an important subsystem of proposed application available to the users. The instructor will be able to administer survey tool integrated as an integral part of eTAT, generate and send surveys to students, branch and direct them to selected group or groups, view responses to those surveys and analyze them through charts, graphs and tables.
In summary, eTAT is a web based tool designed to gather and present teamwork metrics. The tool will be available to instructors teaching software engineering practices in order to assess the collaborative skills of students participating in software development. The most modern software engineering processes and techniques will be used to develop the entire application.

Entry Number: 48 GP
DEVELOPMENT OF A STAINED CELL NUCLEI COUNTING SYSTEM
By: Niranjan Timilsina
Software Engineering
Faculty Advisor: Dr. Kaz Okada
Abstract: There are already some applications that are designed to be used to count the stained cells in the microscopic image obtained from the light microscope. Those applications have a limitation of not being able to count the stained cells if the images obtained are less contrast or the background of the image and the stained cells are less distinct. Also those applications are not effective and efficient against the images obtained from the tissues of varying thickness. This thesis introduces an application, that aims to overcome all such limitations and, is effective and efficient
for the use in biological researches. Various image processing algorithms have been implemented in order to attain maximum accuracy and accurate quantification.

Entry Number: 49 GP
PODCASTING IN MOBILE WiMAX: ANALYSIS AND IMPLICATIONS
By: Saurabh Kumar
Electrical Engineering
Faculty Advisor: Dr. Hamid Shahnasser
Abstract: The IEEE 802.16e-2005 or mobile WiMAX is essentially a metropolitan area network (MAN) wireless technology for providing high-quality broadband service. The system works on Orthogonal Frequency Division Multiple Access (OFDMA) and mainly harnesses the technique of fractional frequency reuse for maximum usage of the allocated spectrum. This paper theoretically examines the feasibility and requirements for podcasting a file of maximum size of 2594kB, which was proposed in a report by WiMAX forum in September 2007, under a specific urban setting. The parameters discussed for theoretical assessment are bandwidth, downlink transmission time, cell spectral efficiency, downlink peak data rate, cell edge user spectral efficiency and total podcasting bandwidth required each month. The values for different assessment parameters are taken accordingly from the report published by the WiMAX Forum in September 2007, apart from some logical assumptions. The WiMAX report forecasts the WiMAX scenario up to year 2020. However, the parameters and its implications are assessed and discussed for the year 2010, in this report.

Entry Number: 50 GP

RELIABILITY ANALYSIS OF POWER GATED SRAM UNDER COMBINED EFFECTS OF NBTI AND PBTI IN NANO-SCALE CMOS

By: Anuj Pushkarna
Electrical Engineering
Faculty Advisor: Dr. Hamid Mahmoodi

Abstract: Transistor aging effects (NBTI and PBTI) impact the reliability of SRAM in nano-scale CMOS technologies. In this research, the combined effect of NBTI and PBTI on power gated SRAM is analyzed. Optimal source biasing in the standby mode is presented as an effective method for guard-banding against the aging effects. The simulations results in a predictive 32nm technology shows maximum of 1.6% reduction in standby SNM over 5 year lifetime. For optimum operation, by decreasing the standby source bias voltage by only 0.012 volts, the SNM is safely margined for 5 year life time. This guard-banding comes at an insignificant power overhead of 0.6% for applied worse case scenarios. Given the insignificant power overhead with such guard-banding, it is concluded that adaptive tuning of the source biasing voltage is not required, given the not so negligible complexity and overhead associated with adaptive techniques.

Entry Number: 51 GP

MAC PROTOCOLS FOR VANETS: ANALYSIS AND THEORETICAL IMPLEMENTATION

By: Shankar Yanamandram
Electrical Engineering
Faculty Advisor: Dr. Hamid Shahnasser

Abstract: The main challenges in formulating efficient Medium Access Control (MAC) protocols for Vehicular Ad-Hoc Networks (VANETs) are the fast mobility of vehicular nodes and hence, the high dynamicity of the network. VANETs present unique characteristics and hence, most MAC protocols for Mobile Ad-Hoc Networks (MANETs) might not be appropriate for VANETs. Research in the field of MAC protocols for VANETs has led to several novel ideas being proposed. This work reviews MAC protocols adaptable for VANETs and compares most recently proposed novel MAC protocols, which consider the 5.9 GHz or Dedicated Short Range Communications (DSRC) band. This thesis attempts to demonstrate how three such proposed VANET MAC protocols have the potential to be combined to realize a MAC protocol that addresses the major requirements of VANETs, namely: efficient use of spectrum, minimization of packet delay, as well as authentication, security and prioritized delivery of safety messages. The thesis also studies implementation of cognitive radio technology in VANETs and multiple MAC protocol adaptation techniques in vehicular communications. A scheme to implement multiple MAC protocols in VANETs employing cognitive radio technology is presented.

Entry Number: 52 GP

COMPARATIVE RELIABILITY ANALYSIS OF SRAM CELL DESIGNS IN NANO-SCALE TECHNOLOGIES

By: Shreyas Kumar Krishnappa
Electrical Engineering
Faculty Advisor: Dr. Hamid Mahmoodi

Abstract: To determine the effect of Process (semiconductor manufacture), voltage, and temperature effect in SRAM circuit design by incorporated Bias Temperature Instability (BTI) model to predict the impact at 32nm technology. Six-transistor, Eight-transistor, Ten-Transistor Static random memory access (SRAM) circuits are simulated in HSPICE. Increase in number of transistor from conventional six-transistor SRAM circuit is crucial for circuits designed to operate in low supply voltage, less than 0.9volts Simulation results showed better performance in low supply voltage, low or high operating temperature for stand-by, active, write margin, read margin for eight-transistor SRAM and ten-transistor SRAM. Simulation is done in 32nm CMOS technology files for a single SRAM cell in each three design. Our result recommend to design and manufacture SRAM circuits with increased number of transistors for better performance in speed, data retention for longer duration, with increased reliability in nano-scale technology.

Entry Number: 53 GP

VERSATILE NETWORKABLE ROBOT

By: Gregory S. Kielian, Di Lan, Xiao Wang, Tao Yu, and Shiyu Zhou
Engineering
Faculty Advisor: Dr. Seapahn Megerian

Abstract: Certain tasks can be best done by -- fixing global-warming, cleaning the Great Pacific Trash Vortex, and creating a sustainable agricultural system. Given an opportunity to create a project using microcontrollers in our embedded system's graduate-level course -- Engineering 844 -- we chose to aid the effort by creating a prototype for a networkable-robot, capable of understanding voice commands with a built in re-programmable "AI." networkable, reprogramable team of robots can be put to direct use to running agricultural tasks, cleaning oceans, and do mundane tasks researchers more time to solve the current crisis.

Entry Number: 54 GP

INTELLIGENT VEHICLE MOBILITY TCL SCRIPT GENERATOR FOR NS-2 SIMULATION

By: Jia Huang
Engineering
Faculty Advisor: Dr. Hamid Shahnasser

Abstract: Tcl scripts are widely used in NS-2 simulation tool. We have developed a new Tcl script generator tool to permit users create Tcl script files in a direct and easy manner. This tool has an important impact on avoiding many accidental syntax errors as well as reducing the number of command lines

Entry Number: 55 GP

ANONYMOUS COMMUNICATION IN MOBILE AD HOC NETWORKS

By: Avisa Tehrani
Enginering
Faculty Advisor: Dr. Hamid Shahnasser

Abstract: Mobile ad hoc network gets more practical everyday because of easy and quick installation. Security in this kind of network becomes more important due to the nature of applications involved, e.g., military and government applications. Mobile ad hoc networks are vulnerable to a wide range of security threats because of the shared wireless medium. These threats are categorized as active and passive attacks. Traffic Analysis is one of the most invisible and unsolved passive security attacks against this kind of network, and anonymous communication is a current solution to traffic analysis attack. This thesis studies the unsolved problems in anonymous communication in Mobile ad hoc networks and proceeds as follows: (1) Define the necessity of using anonymity in mobile ad hoc network in sensitive applications to protect vital information like identity and location of involved parties in a communication. In addition, the current solutions and the pros and cons of each solution are discussed. (2) Current challenges about anonymity in Mobile ad hoc network are explained. (3) The current available solutions in market are introduced and one of them is going to be studied and evaluated. (4) At the end, a new solution is defined and evaluated.

Entry Number: 56 GP

THE DEVELOPMENT OF WiGig VEHICULAR AD HOC NETWORK WITH THE IMPLEMENTATION OF VI-FI AND VANETS

By: Alan Chan
Enginering
Faculty Advisor: Dr. Hamid Shahnasser

Abstract: This paper presents the recently published 60 GHz technology - WiGig. It will introduce the specs of WiGig and discuss some of the characteristics which present a new dimension in the wireless world. Also includes discussions of possible implementation to transform WiGig into a vehicular ad hoc network. To develop a vehicular ad hoc network with WiGig, the limitation of WiGig's transmission range will be the top issue to be resolved. Furthermore, the issue in which trouble all vehicular ad hoc network, handoff switching, will also be discussed. Protocols such as vehicle ad hoc networks (VANETs) and Vehicle Wi-Fi (Vi-Fi) will be

introduced to address the issue. How the two protocols can support WiGig in a vehicular ad hoc network and possible concerns and issues with the implementation of the two protocols with WiGig is discussed.

Entry Number: 57 GP
CONVEXITY OF DOMAINS OF BEST APPROXIMATION
By: Bita Nosratieh
Mathematics
Faculty Advisor: Dr. Yitwah Cheung
Abstract: The study of domains of best approximation typically involves choosing a real number and finding the set of all rational numbers that are closest to that real number. In this study we take a different point of view. To determine the domains of best approximation, we fix a rational point and construct the set of irrationals that this point is a best approximant for. So this set is determined by computing the distance between a fixed rational point and the irrational ones. How we define distance then becomes an important factor. The convexity of these sets is known for the Euclidean norm which raises the question of convexity for general norms; in particular the maximum norm. This research reveals that the domains of best approximation is not always a convex set with respect to the maximum norm.

Entry Number: 58 GP
A MAXIMUM PRINCIPLE FOR THE WEIGHTED BERGMAN SPACE
By: David Bangor
Mathematics
Faculty Advisor: Dr. Alex Schuster
Abstract: The project considers Korenblum's maximum principle for the weighted Bergman space to help understand the nature of Korenblum's constant.

Entry Number: 59 GP
GENERALIZED ORDER AND CHAIN POLYTOPES
By: Dido Salazar-Torres
Mathematics
Faculty Advisor: Dr. Thomas Bliem and Dr. Federico Ardila
Abstract: We used generalized order and chain polytopes to give an easier explanation of why the Gelfand-Cetlin and Feigin-Fourier-Littelmann polytopes have the same number of integer coordinate points and understand their combinatorial relationships by thinking of them as generalized order and chain polytopes.

Entry Number: 60 GP
VARIETY OF FINITARY C-ALGEBRA HOMOMORPHISMS
By: Jon Yaggie
Mathematics
Faculty Advisor: Dr. Joseph Gubeladze
Abstract: Let A and B be arbitrary commutative (unitary) C- algebras. Assume V ? A and W ? B are finite dimensional C-linear subspaces. Denote the sub- algebras of A and B generated by V and Was A(V) and B(W). Then the set Hom(A,B,V,W) of C-algebra homomorphisms f: A(V) ? B(W) such that f(V) ? W is an affine C-variety in a natural way. The structure of the proof of this claim suggests an algorithm could be developed to allow software to calculate the affine variety Hom(A,B,V,W). The goal of my research is to develop software capable of doing this calculation and use this software to compute some classi- cal algebras (e.g. group algebras, monomial algebras etc).

Entry Number: 61 GP

INVARIANCE OF THE SIGN OF THE AVERAGE SPACE WRITHE OF FREE AND CONFINED KNOTTED POLYGONS

By: Juliet Portillo, Rob Scharein, and Dr. Javier Arsuaga
Mathematics
Faculty Advisor: Dr. Mariel Vazquez

Abstract: Our group studies topological properties of DNA molecules in solution. We consider highly compacted models of knotted DNA, such as DNA extracted from P4 phages. Circular DNA molecules are modeled as self-avoiding polygons (SAPs) in three-dimensional space. Using different Monte Carlo algorithms, we sample the space of knotted SAPs and study knotting probabilities. To better understand how DNA knotting is affected in confined environments, we generate knotted configurations confined inside small spheres. Writhe is a geometric invariant that measures the entanglement complexity of a given configuration. A comparison of the writhe of confined versus free knots suggests that the sign of the average writhe is invariant for each chiral knot type under varying polygonal lengths on the simple cubic lattice and in R3. We propose that the sign of the average space writhe is a robust measure of knot chirality.

Entry Number: 62 GP

INTERPOLATION IN THE UNIT DISK

By: Tim Wertz
Mathematics
Faculty Advisor: Dr. Alex Schuster

Abstract: Interpolation problems in spaces of analytic functions have a long history.^{4} While the definition of interpolation is a bit technical, the idea is relatively straightforward. When beginning algebra students learn to find the equation of a line passing through two points, they are solving an interpolation problem. In this research we extend previous interpolation results on a particular type of function space to a new space of weighted sequences.

Entry Number: 63 GP

AN EXPLORATION OF BFACF ENTROPY & BIOLOGICAL APPLICATIONS OF SELF-AVOIDING POLYGONS IN THE SIMPLE CUBIC LATTICE

By: Zoe Talbot
Mathematics
Faculty Advisor: Dr. Yitwah Cheung, Dr. Rob Scharein, and Dr. Mariel Vazquez

Abstract: DNA, the code of life, sometimes appears as a closed loop, or knot. This work aims to explore the space of conformations adopted by a circular DNA molecule of fixed length and knot type as it moves freely in solution. To this end we use the BFACF algorithm, a Monte Carlo simulation method, to sample the space of knots in the simple cubic lattice. It has been shown that the BFACF algorithm, due to Bergs, Foester, Aragao de Carvalho, Caracciolo, and Frohlich, is ergodic within classes of knots [3]. The BFACF algorithm generates a Markov chain of SAP's of knot type K which we use to study the space of conformations. However, an SAP in the simple cubi lattice is not the most realistic model of DNA due to bending and rigidity constraints of the space. In a step toward refining the model, we will closely examine the geometric variations within given topological constraints of SAP's by introducing a novel concept: the BFACF entropy of an SAP. We here prove the theoretical bounds for the ratio of BFACF entropy, e(omega), to length, l(omega). That is to say, we have proven that within any knot class K there exists an SAP omega such that the infimum of the ratio of entropy to length is 0 and the supremum is 4. By using BFACF entropy we can learn more about the geometric properties of SAP's generated by the BFACF algorithm.

Entry Number: 64 GP

INFERRING TREE TOPOLOGIES USING PHYLOGENETIC INVARIANTS

By: Addie Evans
Mathematics
Faculty Advisor: Dr. Serkan Hosten

Abstract: Phylogenetic trees are used to explain evolutionary relationships between taxa. Phylogenetic invariants is a burgeoning method of testing competing tree topologies using algebraic geometry and statistics. Current methods fall into two categories: distance algorithms and likelihood methods. The method of phylogenetic invariants tests tree topologies without having to estimate branch lengths, which is proportional to sequence divergence. This method uses constraints placed on the probability space of the DNA site patterns in order to find the true tree.

Entry Number: 65 GP

CLASSIFICATION OF EHRHART QUASI-POLYNOMIALS OF HALF-INTEGRAL POLYGONS

By: Andrew Herrmann
Mathematics
Faculty Advisor: Dr. Matthias Beck

Abstract: Convex polytopes are particularly nice objects, and are found throughout mathematics. Given a polygon P whose vertices have rational coordinates, we can dilate P by some positive integer t, yield {tx:x in P}. A natural combinatorial question arises: given a polygon, how large is {tP}(intersect){Z^2}? A theorem give by Eugen Ehrhart states that given a polygon P as above, the number of lattice points in the t^th dilate of P is given by a quasi-polynomial (a polynomial whose coefficients are periodic in t). Here, we describe all polygons with half-integral vertices by describing the coefficients of their corresponding quasi-polynomials.

Entry Number: 66 GP

THE IMPORTANCE OF THE LEADOFF BATTER

By: Eric Distad
Mathematics
Faculty Advisor: Dr. Serkan Hosten

Abstract: We study the impact of walking the leadoff batter of an inning of a professional baseball game. In addition to comparing the percentage of walked leadoff batters that eventually score against that of non-walked leadoff batters, we compare the average runs scored across the same metric. This quantifies the positive or negative impact of such an occurrence. Finally, we examine the impact of giving a free base to the leadoff batter to winning games.

Entry Number: 67 GP

GRAPH OPERATIONS IN TROPICAL GEOMETRY

By: Eric Douglas Miranda
Mathematics
Faculty Advisor: Dr. Serkan Hosten

Abstract: From a connected, loopless and directed graph G we obtain a linear subspace of a vector space V. Through the linear operations of deletion and contraction on G we obtain a new graph G_. We identify the at structure of G and G_ with Trop(G) and Trop(G_) respectively. The lattice of ats gives rise to inequalities and equations of each cone in Trop(G). Under edge contraction we de_ne a piece-wise linear tropical map g which takes Trop(G) to Trop(G_); in other words, g linearly maps chains of ats of G to chains of ats of G_. Finally we give necessary and su_cient conditions for g to be surjective.

Entry Number: 68 GP

EFFECT OF COAL-FIRED POWER GENERATION ON VISIBILITY IN A NEARBY NATIONAL PARK

By: Jonathan Terhorst
Mathematics
Faculty Advisor: Dr. Serkan Hosten

Abstract: The Mohave coal-fired power plant has long been considered a major contributor to visibility impairment in Grand Canyon National Park. The permanent closure of the plant in 2005 provides the opportunity to test this assertion. Although this analysis, based on data from the Interagency Monitoring of Protected Environments (IMPROVE) Aerosol Network, shows that fine sulfate levels in the park dropped following the closure, no statistically significant improvement in visibility resulted. Difference-in-differences estimation was used to control for other influences. This finding has important implications for the methods generally employed to attribute visibility reductions to air pollution sources.

Entry Number: 69 GP

A LATTICE POINT ENUMERATION APPROACH TO PARTITION IDENTITIES

By: Nguyen Le
Mathematics
Faculty Advisor: Dr. Matthias Beck

Abstract: A partition of a positive integer t to be a list of positive integers (a_1, a_2, ...,a_k) arranged in descending order whose sum is t. The order of a partition gives rise to a system of diophantine relations; a_1>=a_2>=....>=a_k, which can be altered to produce various forms of partitions. In this paper, we use counting lattice point in polyhedral cones method to reprove generating functions of some partition identities which are prove in MacMahon's partition analysis by the Omega Operator.

Entry Number: 70 GP

TORIC IDEALS OF SMALL MATROIDS ARE GENERATED IN DEGREE 2

By: Ronald Youtz
Mathematics
Faculty Advisor: Dr. Serkan Hosten

Abstract: Neil White has conjectured that the toric ideal associated with a matroid is generated by quadratic binomials associated with double swaps. We prove this conjecture for matroids of rank 2. Also, we use computations to confirm the conjecture for matroids on ground sets of size nine or less.

Entry Number: 71 GP

HUNTING FOR COMPACT GALAXIES

By: Claire Davy, Zach Hoch, and Stephen Pehrson
Physics and Astroshysics
Faculty Advisor: Dr. Ron Marzke

Abstract: Compact elliptical galaxies are rare objects that populate a puzzling gap in the expected continuum of galaxy morphology. Their compact structure may hold clues to the earliest stages of galaxy formation. Unfortunately, their compactness also makes them difficult to distinguish from stars in our own galaxy. In order to separate these rare compact ellipticals from the much more numerous foreground stars, we use a telltale feature in their optical and infrared colors. As part of an ongoing study of these compact systems, we used multifilter imaging collected at the Southern Astrophysical Research (SOAR) 4.1m Telescope in February of 2008 to search for compact galaxy candidates in the environs of a dozen large, bright galaxies. During the first phase of this search, we discovered a likely compact elliptical, one of just a handful currently known. In April 2010 we submitted a proposal to SOAR requesting detailed spectroscopy of this candidate to determine its essential features: its redshift, its star formation history, and its chemical content.

Entry Number: 72 GP

OPTICAL TAPPING AND MANIPULATION

By: Daniel Hernandez
Physics
Faculty Advisor: Dr. Zhigang Chen

Abstract: We are exploring existing techniques for optical trapping and manipulation as well as new, novel methods. Specifically, we aim to use optical beams including vortices, rotating, Bessel, and Airy beams to manipulate, sort, clear and perhaps classify micron-sized particles.

Entry Number: 73 GP

THE IMPACT OF A 5E CONCEPTUAL CHANGE APPROACH TO ASTRONOMY EDUCATION

By: Michelle Krok
Physics
Faculty Advisor: Dr. Adrienne Cool and Dr. Kimberly Tanner

Abstract: Employing the research-based curricular planning approach called the 5E Model (Engage, Explore, Explain,Elaborate, Evaluate), we developed five planetarium-based labs for non-science majors to teach students how to predict the apparent motions of the Sun, Moon, and stars from different positions on Earth. Our goal was to determine the effectiveness of the curriculum's ability to foster conceptual change over the course of a semester for two classes (N=33). We also assessed student confidence and interest. Open-ended responses preceded by a multiple choice question were used to assess student content knowledge before and after each laboratory. We found positive shifts for pre to post instruction for 14 out of the 16 assessments (87%) based on quantitative analysis of the closed-ended responses. Qualitative results will be presented as a result of analysis on the open-ended responses.

Entry Number: 74 GP

PHOTONIC BANDGAP MATERIAL WITH QUASI-CRYSTALLINE SYMMETRY

By: Polin Yadak and Kazue Matsuyama
Physics
Faculty Advisor: Dr. Weining Man

Abstract: Photonic band gap materials are structured electromagnetic media which affect the motion of photons and possess ban gaps. They can be designed and constructed to prevent photons with certain frequency propagating in certain directions. Their ability to confine and control electromagnetic waves around sharp bends and along well controlled optical paths makes them useful for telecommunication and quantum computing. Multiple scattering of photons due to the Bragg's condition in Brillouin zone boundaries prevent photons from propagating in theses directions, producing a stop gap. Conventional crystalline photonic bandgap materials have limited rotational symmetry and different periodicity in different directions, which makes it hard to get complete photonic bandgap in all directions. We designed and fabricate photonic quasicrystals with more isotropic symmetry than crystalline structures. And we use microwave transmission experiments to characterize their photonic properties.

We confirmed the existence of nearly isotropic photonic bandgaps with small angular dependence in 2 dimensional Penrose quasicrystal. Furthermore, we compared rods connected 3 dimensional isocahedral quasicrystals with the diamond structure, the known best 3D crystalline structure, and confirmed that isocahedral quasicrystals have better structure symmetry to form a complete photonic bandgap. We also explored the effect of the building blocks geometry in icosahedral quasicrystal on photonic bandgaps and found that thicker dielectric rods have wider and deeper bandgaps. These results are useful for future design of photonic bandgap materials, hence they can be important to photonic technologies.

Entry Number: 75 GP

THE MAIN SEQUENCE BINARY FRACTION IN GLOBULAR CLUSTER NGC6397

By: Srikar Srinath
Physics
Faculty Advisor: Dr. Adrienne Cool

Abstract: The fraction of stars in a globular cluster that are binary has a major impact on the dynamics and evolution of the cluster. Using image data from the Hubble Space Telescope, this project attempts to measure the fraction of a particular class of binary stars: Main Sequence Binaries, or sun-like stars that orbit each other.

Entry Number: 76 UL

ECDYSIS TRIGGERING HORMONE INDUCES FICTIVE PRE-ECDYSIS AND ECDYSIS IN INTERMOLT PERIOD OF TOBACCO HORNWORM NERVOUS SYSTEMS

By: Ariel Aveo and Tyson Buis
Physiology and Behavioral Biology
Faculty Advisor: Dr. Megumi Fuse

Abstract: Ecdysis Triggering Hormone (ETH) is a peptide synthesized from peripheral glands lining the body wall of the hornworm, Manduca sexta.Fictive pre-ecdysis and ecdysis bursting patterns linked with the shedding of the old cuticle in the isolated nervous system (Zitnan et al, 1996) has been shown at the end of each molt. The role of ETH during the intermolt period, however, has not been as well characterized. The beginning of the molt period is made distinct by a large increase in ecdysteroid titers, which has been suggested to be required for ETH activity. In vitro fictive pre-ecdysis and ecdysis behaviors were monitored through extracellular electrophysiology in response to prolonged exogenous ETH exposure, at intervals after the normal molt period. In intermolt preparations, fictive pre-ecdysis and ecdysis occurred from up to 72 hours post-ecdysis, although burst characteristics and onset times were altered. In contrast, injection of ETH into similarly timed animals did not induce pre-ecdysis or ecdysis behaviors. These data show that ecdysteroid-induced CNS activity is not necessary for ETH-induced fictive pre-ecdysis and ecdysis in intermolt larvae. It also suggests that low levels of ETH receptors are sufficient for ETH activity in vitro.

Entry Number: 77 UL

SPATIAL PATTERNING OF MUSCLE FIBERS IN XENOPUS LAEVIS

By: Armbien Sabillo and Vanja Krneta-Stankic
Physiology and Behavioral Biology
Faculty Advisor: Dr. Carmen R. Domingo

Abstract: Mesoderm cells of the early embryo become the muscle fibers of the adult. During embryo development, mesoderm cells elongate into muscle fibers and form transient structures called somites. To understand how mesoderm cells of the early embryo organize to become the muscle fibers of the somites, we tracked cell movement as the embryo developed, using the African Clawed Frog (Xenopus laevis) as a model system. Using a cell-transplantation approach, we found that specific regions of the early embryo gave rise to muscle fibers in specific locations in the somites of the tadpole. We also found that this spatial fate is determined by signals sent by the host embryo. To determine whether the elongating notochord affects the positioning of muscle fibers within somites, we tracked cell movement in embryos whose notochord had been surgically removed. We found that notochord removal did not influence the position of the muscle fibers within the somites of the tadpole. This suggests that muscle fibers position themselves independent of the notochord. We also found that removing the notochord shortened the overall length of the body axis. These results offer new insights into how cells migrate as the embryo forms muscle, and contribute to our understanding of embryo development.

Entry Number: 78 UL

ROLE OF ROR1 IN THE DEVELOPING CHICK NEURAL TUBE

By: Camilla Teng
Cell and Molecular Biology
Faculty Advisor: Dr. Laura Burrus

Abstract: Neural tube closure defects, such as spina bifida and anencephaly, cause severe problems in newborn babies. Wnts, a family of secreted signaling proteins, contribute to normal neural tube development and several mutations amongst this class of signaling proteins have been implicated in neural tube defects. Equally important in neural tube development are the Wnt receptor proteins, Frizzleds and two receptor tyrosine kinases, Ror1 and Ror2. Frizzleds are seven-pass transmembrane proteins that contain cysteine-rich domains, which are capable of binding to multiple Wnt family members. Rors also possess cysteine-rich domains that are thought to bind to Wnt family members. There are two predominant signaling pathways for Wnts – a β-catenin dependent pathway and a β-catenin independent pathway; in addition, there is evidence of cross talk between the pathways. While Ror2 has been shown to mediate Wnt3a signaling via the β-catenin dependent pathway, both Ror1 and Ror2 have been found to mediate Wnt5a signaling through a β-catenin independent pathway, resulting in the inhibition of the β-catenin dependent pathway. These data suggest that depending on which Wnt is bound to the receptor, different pathways can be excited. Although Ror1 is not as well studied as Ror2, I expect it to act similarly to Ror2 because of its homology to Ror1. On one hand, previous experiments in our lab have shown that Ror1 transcripts co-localize with Wnt3a in the dorsal neural tube, thus, leading us to hypothesize Ror1 signals via the β-catenin dependent pathway. On the other hand, the similarity in phenotype of Ror1/Ror2 double knockout mice to that of Wnt5a mutant mice leads us to hypothesize that Ror1 signals via the β-catenin independent pathway in the neural tube. The goal of my research is to distinguish between the two competing hypotheses. To test the role of Ror1, I knocked it down in the developing chick neural tube and analyzed the affects in transverse sections. Because I found that the experimental side of the neural tube to be smaller in comparison to the control side, I tested for apoptosis. I observed that Ror1 knock down resulted in an increase in cell death. However, it remains unclear if this result is linked to a disruption of Wnt signaling. To test if β-catenin signaling is disrupted, I am in the process of co-electroporating a Ror1 knock down construct with a Wnt/β-catenin signaling reporter construct (BAT-GAL) into developing chick neural tubes. By doing so, I will determine if Ror1 regulates the Wnt/β-catenin dependent pathway. This knowledge will greatly enhance our understanding of Wnt signaling and may lead to therapeutic research for neural tube closure defects.

Entry Number: 79 UL

LOSS OF MEMBRANE RAFTS DEREGULATES INTRACELLULAR FREE CALCIUM IN C2C12 MYOBLASTS/MYOTUBES

By: Romica Kerketta
Cell and Molecular Biology
Faculty Advisor: Dr. Wilfred Denetclaw

Abstract: Methyl Beta Cylodextrin (MBC) is a drug that is known to disrupt lipid membrane rafts by extracting cholestrol from the membranes. Lipid raft disruption leads to disruption of a number of ion channels including calcium ion channels. My study focuses on studying the calcium dynamics in C2C12 cells which are mouse myoblast cells under the effect of the drug MBC. Prelimenary experiment has shown that under the effect of MBC, C2C12 cells show a higher level of intracellular calcium concentration when compared to cells not treated with MBC and this effect is obvious within 90 minutes of the drug treatment.

Entry Number: 80 UL

ECTODERM EXPRESSED DYNAMIC LEVELS OF Ca2+I AND NO RESULT IN PATTERNS OF CELL DEATH TO COINCIDE WITH SIGNALING ACTIVITY BY THESE MESSENGERS FOR CHICKEN EMBRYO DEVELOPMENT

By: Shivalee Gujarathi and Seung Jong Lee
Cell and Molecular Biology
Faculty Advisor: Dr. Wilfred Denetclaw

Abstract: The ectoderm of chicken embryos provides important signals for the development of the paraxial mesoderm including regulating somite and myotome formation. There are few in situ physiological studies of embryo development and how physiological regulators control embryo growth and morphogenesis is poorly understood. We show that the ectoderm shows dynamic levels of nitric oxide (NO) and intracellular free calcium (Ca2+i) that signal to the underlying paraxial mesoderm during somite differentiation. To investigate further physiological changes in ectoderm, we used the fluorescent vital dye FM4-64, a lipophilic styryl compound that strongly incorporates into the exoplasmic layer of the plasma membrane bilayer to become fluorescent, and that shows an increased fluorescence intensity due to second harmonic generation following membrane potential change. On FM4-64 ectoderm labeling and confocal microscopy, the ectoderm revealed a unique pattern of fluorescence. In HH14 chick embryos, strong dye labeling was also found more posterior in the embryo but much more sparse above the neural tube into Hensen's Node. The strong dye fluorescence was also present as a lateral symmetrical line moving out from Hensen's Node towards the forming lateral plate mesoderm. There, the strong dye fluorescence was present in a few cells over the segmental plate mesoderm and above the nascent somites. In more mature somites, the FM4-64 fluorescence in cells became greater towards the medial somites and neural tube to account for the greater dye signal in the anterior embryo. To determine if strong FM4-64 fluorescence could be due to membrane potential, HH14 embryos were treated with 3mM KCL. No change in the strongly fluorescent cells resulted but other ectoderm cells showed increased FM4-64 fluorescence. The inability to alter the bright cells suggested that these cells were dead and that the strong fluorescence was due to a high accumulation of FM4-64 into membranes with an absence of plasma membrane turnover. To confirm this, we used a different membrane dye, DeepRed, with Trypan Blue to identify dead cells. DeepRed showed a similar pattern of strong fluorescing cells in ectoderm like FM4-64 and these cells took in Trypan Blue. Therefore, we conclude that the unique pattern of FM4-64 labeling in the ectoderm is due to cell death and that this pattern reflects a more global pattern of change in the ectoderm. Ca2+i and NO probes in the ectoderm produce a much more extensive fluorescence pattern that would encompass the FM4-64 pattern. This suggests that an active and dynamic Ca2+i and NO signaling activity in the ectoderm eventually causes cell death in some of these cells as revealed by FM4-64 and DeepRed membrane dyes. NSF-IOS 0821324.

Entry Number: 81 UL

GENOMIC SIGNATURES ASSOCIATED WITH RECURRENCE IN BREAST CANCER PATIENTS

By: Alex Pankov
Mathematics
Faculty Advisor: Dr. Javier Arsuaga

Abstract: Breast cancer is the second most common occurring form of cancer for women and is diagnosed in 1 in 8 women. Therefore, it is essential to properly diagnose the risk of cancer recurrence. However, because of a lack of indicators of patients' risk level, many women are unnecessarily exposed to aggressive chemotherapy treatment. An assessment of various predictive indicators would ideally pave the way for a more personalized healthcare plan which would work to help each individual patient.

An approach to study this problem, that complements current expression profiling, is to look at the genomic alterations. These genomic aberrations can be detected through the use of array comparative genomic hybridization (aCGH) technology. Here, I will discuss the various algorithms that are used to detect region of copy number aberration and the benefits of each method.

Entry Number: 82 UL

USING THE MATHEMATICS OF TANGLES TO STUDY THE MECHANISM THE CELL EMPLOYS TO MAINTAIN GENETIC STABILITY

By: Mousa Rebouh
Mathematics
Faculty Advisor: Dr. Mariel Vasquez

Abstract: Site-specific recombinases perform topological manipulations on cellular DNA in order to mediate a number of biological processes. Occasionally, two genomes unite during replication to form circular dimers that are knotted or linked, and this leads to plasmid instability. The cell needs some kind of machinery to properly segregate these dimers prior to septation at cell division. In the Escherichia Coli chromosome, and in some naturally occurring plasmids (like pSC101, for instance), the Xer site-specific recombination system performs this cell cycle maintenance function. Since the mechanism of many recombinases involves local interaction of two DNA strands bound to a protein, the mathematics of 2-string tangles offer the appropriate tools to model this interaction. Tangle analysis has been used successfully to study the topological mechanism of many recombinases (e.g. Int, Cre, Tn3), including XerCD, however all studies thus far focused on unknotted or linked substrate. Here we apply the tangle method to study the topological mechanism associated with the Xer system when the substrate is knotted.

Entry Number: 83 UL

DETERMINING THE KINETIC MECHANISM OF STYRENE MONOOXYGENASE REDUCTASE

By: David Canio
Biochemistry
Faculty Advisor: Dr. George Gassner

Abstract: Styrene Monooxygenase is a two component enzyme consisting of an FAD specific epoxidase and an NADH specific reductase. The enzyme is involved in the metabolism of styrene, a synthetic used in the production of plastic products, which is converted into a carcinogenic intermediate known as styrene oxide. SMOB (the reducatse component) reduces FAD to FADH with NADH in a mechanism to be yet be determined. The lab hypothesizes that NADH binding promotes the affinity of FAD at a second active site of SMOB. We also hypothesize that both binding sites may be occupied by oxidized FAD causing inhibitive effects to SMOB activity. To determine these hypotheses, FAD dependent and NADH dependent kinetic studies were done. FAD dependent experiments have shown that the pre-steady state kinetic rates are independent of substrate concentrations in pseudo first-order settings. FAD reduction rates range between 4 to 7 uM/s at 4°C. The NADH dependent experiments suggest that there are two separate kinetic phases of SMOB that are being viewed. Temperature dependant studies have also been done in order to see its effects of rates and to determine estimations of thermodynamic values. This concluded with determining an activation energy value of 38.26 kJ/mol and enthalpy value of 51.31 kJ/mol at 25°C.

Entry Number: 84 UL

DETERMINING THE CONFORMATIONAL EFFECTS CAUSED BY CO AND YC-1 BINDING TO SOLUBLE GUANYLATE CYCLASE

By: Ignacio López-Peña and Jasmine Kristianto
Biochemistry
Faculty Advisors: Dr. Nancy Gerber and Dr. Raymond Esquerra

Abstract: Soluble guanylate cyclase is a heme-based sensor that binds the gaseous ligands NO and CO. The binding of these ligands starts a signaling cascade by prompting active sGC to convert GTP to cGMP, which ultimately results in vasodilation and memory formation. NO activates sGC at least 200-fold, while CO-sGC only marginally increases activity. However, in the presence of the allosteric effector YC-1, the CO complex is activated to a level nearing that caused by the NO complex. Our objective is to understand the molecular mechanism by how YC-1 binding induces sGC sensitization to activation by CO. We used MCD to probe the electronic environment of the heme sensing site and FRET to probe for conformational changes as a function of YC-1 binding. The findings presented here indicate that the heme electronic environment is not affected by YC-1 binding, while conformational changes occur when CO and YC-1 bind. These results suggest that a region

outside of the heme environment can bind small molecules and induce the conformational changes required for sensitization to CO.

Entry Number: 85 UL

DEVELOPMENT OF A BROAD-BASED ASSAY TO MEASURE FLAVIN TRANSFER EFFICIENCY IN THE STYRENE DEGRADATION PATHWAY

By: Matt Gallagher
Biochemistry
Faculty Advisor: Dr. George Gassner

Abstract: This communication describes a technique to measure coupling efficiency between styrene monooxygenase A and styrene monooxygenase B of the styrene degradation pathway in the Pseudomonas putida S12 strain. Previous experiments have utilized dual wavelength monitoring at 245 nm and 340 nm combined with a subsequent deconvolution of the data. The method described here attempts to directly measure both consumed substrate, NADH, and a product of the decoupled side reaction, hydrogen peroxide. Results indicate that the assay is both sensitive and accurate and has determined coupling efficiencies at various ratios of enzyme concentrations. The most efficient coupling occurred when no FAD was added, showing a decrease in efficiency as FAD concentration increased. A secondary effect on coupling efficiency was observed as [SMOA] was in excess of [SMOB]. This method is now available for the evaluation of various flavin species typically found in cells, including FMN and Riboflavin.

Entry Number: 86 UL

COMPARISON OF DEUTERIUM MONOXIDE AND HYDROGEN MONOXIDE SOLVENT EFFECTS ON DIFFERENT SPECIES OF MYOGLOBIN LIGAND REBINDING AFTER CO PHOTOLYSIS

By: Natalie Davis
Biochemistry
Faculty Advisor: Dr. Raymond Esquerra

Abstract: The purpose of this experiment was to determine the ligand rebinding affinity of different species of myoglobin in deuterium monoxide (D2O) and hydrogen monoxide (H2O) using photolysis. Myoglobin is a globular protein of containing a heme prosthetic group in the center as well as eight alpha helices and a hydrophobic core. The iron atom within the porphyrin ring is connected to one of the helices through His93 and to four nitrogens. The remaining helices are free to bind small molecule ligands. The amino acid of interest was the distal His64 which is thought to control the binding of myoglobin to O2 and CO. Altering the solution the myoglobin is suspended within should change the affininty for the rebinding of O2 and CO due to size and polarity. Horse heart and sperm whale myoglobin species was studied. The myoglobin species were placed in D2O and H2O. The H2O was used as a control as the effects on myoglobin ligand dissociation have been previously studied. These samples were purified and deoxygenated using CO and sodium dithionate. The prepared samples were hit by a Nd:YAG (yttrium aluminum garnet) laser to dissociate CO from the heme pocket. Time-resolved absorption spectroscopy monitored the kinetics of the water entry into the distal pocket created by the CO dissociation followed by the re-association of the CO. The absorptions were monitored over a range of wavelengths from 300 to 700 nm during spaced time points of about 20 ns to 20 ms. The absorption data was analyzed using biochemical mathematics and the computer program MATLab. The kinetics were analyzed with the equation $A(\lambda,t)=U(\lambda) \times S \times VT(t)$ where U, S and VT represent separate matrices. The myoglobin was being studied to determine the effect of how mutating myoglobin protein barriers for CO alter the ligand rebinding affinity. This study also verified the importance of His64 and its role in associating ligands within the distal heme pocket.

Entry Number: 87 UL

ANALYTICAL PROTOCOLS FOR DETERMINATION OF PHTHALATES IN TOYS.

By: Patience Adagba
Biochemistry
Faculty Advisor: Dr. Pete Palmer

Abstract: Phthalates are commonly used in PVC-based consumer products. The US Congress recently passed legislation banning the use of six different phthalates in children's toys and other products. GC/MS is the method of choice, as it can provide definitive compound identification and more than adequate sensitivity. Nevertheless, faster methods are needed to screen large numbers of products and ensure manufacturer compliance and consumer protection. This study explores the use of alternate methods for this application. In this study, products are scanned with a portable XRF analyzer to determine if they contain chlorine, DART-MS is used for direct identification of phthalates via accurate mass measurement, and headspace and SPME prior to GC/MS analysis. Results from the application of this protocol to real world samples will show its utility as a faster and more efficient means of assessing phthalate content in consumer products.

Entry Number: 88 UL

SERINE PROTEASE: TRYPSIN VARIANT F41A

By: Quynh Nguyen
Biochemistry
Faculty Advisor: Dr. Teaster Baird, Jr. and Mie Lansang

Abstract: My project involves in working with the Serine Protease Trypsin where the phenylalanine at postion 41 is replaced with alanine. The protein is expressed, purified, and examined by kinetic assay with G-GPR-pNA to see the activities of the variant comparing to wildtype trypsin

Entry Number: 89 UL

INTRODUCING NOVEL SUBSTRATE SELECTIVITY INTO TRYPSIN THROUGH REDESIGN

By: Sayeeda P. Najibi
Biochemistry
Faculty Advisor: Dr. Teaster Baird, Jr

Abstract: The objective of this research was to evaluate how a residue with hydrogen bond capability may affect substrate selection by a previously engineered threonine protease. C42S/C58V/S195T trypsin (SVT-Tn) was characterized and compared to trypsin variants C42A/C58V/S195T-Tn (AVT-Tn) and C42A/C58A/S195T (AAT-Tn). p-Nitroanilide (pNA) and 7-amino 4-methyl coumarin (AMC) derivatives of benzyloxycarbonyl-Gly-Pro-Arg (Z-GPR) were use to kinetically evaluate the activity and specificity of SVT-Tn. Their respective kcat/KM values show that SVT-Tn is 8- and 40-fold more efficient in Z-GPR-pNA and Z-GPR-AMC hydrolysis, respectively, than AVT-Tn. Additionally, SVT-Tn was 5-fold less efficient in Z-GPR-pNA hydrolysis and 2-fold more efficient in Z-GPR-AMC hydrolysis than AAT-Tn. However, the (kcat/KM)pNA/(kcat/KM)AMC ratios show that SVT trypsin is 3.5-fold more selective for the pNA substrate, less discriminatory than the AVT and AAT variants. The results suggest that a serine at position 42 in the S195T/C58V context significantly affects catalytic efficiency in a substrate dependent manner for the two substrates tested, but selectivity between the two substrates was only moderate. However, longer peptide substrates are needed to thoroughly evaluate the degree of the selectivity of SVT-Tn.

Entry Number: 90 UL

ARYL-HETEROARYL UREAS (AHUs) BASED ON 4-AMINOQUINALDINE AS INHIBITORS OF THE INSULIN-LIKE GROWTH FACTOR RECEPTOR

By: Terrence O'Brien
Biochemistry
Faculty Advisor: Dr. Marc Anderson

Abstract: The insulin-like growth factor system is an attractive target for the development of new anticancer drugs. The IGF system is composed of two ligands, IGF-1 and IGF-2, and their receptor, IGF-1R, which is a receptor tyrosine kinase. In addition to its normal role for cell growth, IGF-1R is especially prevalent in breast

and prostate cancers. PQ-401 is an aryl-heteroaryl urea (AHU) compound that is derived from 4-aminoquinaldine and a substituted aromatic ring, which been shown to inhibit IGF-1R with an in vitro IC50 value of 15.5 μM. Our goal is to generate analogs of PQ-401 with improved potency against IGF-1R... Initially our work has focused on the homologation of an aryl methoxy group on the substituted aromatic ring. From there, we investigated the effects of the incorporation of an additional nitrogen into the quinoline ring, creating a class of heterocycles known as 4-aminonaphthyridines. This addition was proposed to exploit polar contacts in the ATP binding site, according to docking studies. Lastly, we explored analogs of PQ-401 with novel electron withdrawing substituents at the quinoline 2 position, namely analogs that incorporate 4-amino-2-trifluoromethylquinoline. Screening of our new class of inhibitors has indicated that the 2-trifluoromethylquinoline inhibitors have somewhat improved IC50 values (3 μM). Additional optimizations of this scaffold are underway.

Entry Number: 91 UL

USING A YEAST SCREENING TO IDENTIFY SITRT INHIBITORS FROM MARINE-DERIVED ACTINOMYCETES

By: Van Pham
Biochemistry
Faculty Advisor: Dr. Taro Amagata

Abstract: Class III HDACs (SIRTs) have been receiving global attention as anticancer target molecules. Currently, a dozen of classical HDAC inhibitors (classes I and II HDACs) are being evaluated as anticancer drugs in clinical trials. In 2006, one of the HDAC inhibitors, SAHA (Zolinza®), was approved as a drug for the treatment of cutaneous T-cell lymphoma (CTCL) by the FDA. Although SIRT inhibitors have great potential to be a new class of anticancer drugs, no potent SIRT inhibitors have been discovered from natural resources. The research focuses on: (1) indentifying marine-derived actinomycetes that produce SIRT inhibitors using yeast assay, and (2) dereplication of active-strain crude extracts. A crude extract library was developed from 70 different actinomycetes separated from deepwater and shallow-water marine sediments. This chemical library was applied to a yeast strain with Ura3 reporter gene in the telomere region. Active strains were screened for selective toxicity in media containing 5-Fluorooritic acid (5-FOA) against media without 5-FOA; in the presence of active strains, 5-FOA would consequently be converted into 5-Fluorouracil (5-FU), a toxic compound. This yeast assay provided several active strains. In this presentation, the results obtained from the yeast screening and dereplication of active hits by LCMS analysis will be shown.

Entry Number: 92 UL

INCREASED OXIDATIVE STRESS IN PEOPLE WITH DIABETES: THE EFFECT OF GLYCATION ON THE KINETICS OF THE ADULT HUMAN HEMOGLOBIN

By: Yadiel Kinfu
Biochemistry
Faculty Advisor: Dr. Raymond Esquerra

Abstract: My project focuses on seeing the effect of glycation on the human hemoglobin. If the rate of autoxidation is increased in people with diabetes, then this means that the disruption of the normal physiology of hemoglobin can lead to serious health problems for diabetics. Understanding this may give us a better insight into the molecular mechanisms of increased oxidative stress in people with diabetes.

Entry Number: 93 UL

SYNTHESIS OF TRIMETHYLLYSINE-SUBSTITUTED PHEOPHORBIDE-A SILICON COMPLEX

By: Anthony Trinh
Biochemistry
Faculty Advisor: Dr. Uschi Simonis

Abstract: The localization of photosensitizers into mitochondria is important for cell death by apoptosis rather than necrosis in Photodynamic Therapy (PDT). To study the uptake of photosensitizers into adenocarcinoma prostate cancer cells, lysine-substituted pheophorbide-a complex (LysPh-a) was synthesized and characterized. Pheophorbide-a (Ph-a) was coupled with Nε-(tertbutoxycarbonyl)-L-lysine methyl ester (H-Lys[Boc]-OMe) to

yield Lys[BOC]Ph-a. The protecting group, BOC, was then removed by reacting Lys[BOC]Ph-a with HCl in dioxane yielding LysPh-a. Lys[BOC]Ph-a was successfully synthesized which was revealed by 1H NMR spectroscopy. Multiplet peaks characteristic of lysine were detected at 2.6, 2.4, 2.2, 1.9, 1.3, and 1.0 ppm. The protecting group, BOC, was revealed by the presence of an –OC(CH3)3 singlet peak located at 1.2 ppm and an –OCH3 at 3.6 ppm. The removal of the protecting group, BOC, was revealed by the absence of the BOC peaks and the presence of the lysine peaks in NMR spectroscopy. UV-Vis Spectroscopy revealed the photosensitizing ability of LysPh-a by a soret band at 407 nm and 4 Q-bands at 506, 536, 608, and 665 nm. The 4th Q-band at 665nm, red light, has the highest absorption and is essential for PDT. Photosensitizers such Ph-a, is a good choice for PDT. Metallation of Ph-a, to form a metal center may be considered to improve its properties to be more suitable for PDT

Entry Number: 94 UL

PHOTODYNAMIC THERAPY OF CANCER DISEASES SYNTHESIZE OF METHOXY L-LYSYLPYROPHEOPHORBIDE–A AND ITS ZINC METAL

By: Abdelaziz Mtaoua
Chemistry
Faculty Advisor: Dr. Uschi Simonis

Abstract: Scientific studies have shown that successful photodynamic therapy (PDT) is based on an excellent photosensitizer, which can treat cancer and other serious diseases. To improve the effectiveness of photosensitizers in photodynamic therapy (PDT), a derivative of pyropheophorbide-a was prepared by a traditional method of peptide coupling. Methoxy L-lysyl pyropheophorbide-a was prepared by peptide coupling and followed by insertion of zinc (II) into the ring of methoxy L-lysylpyropheophorbide-a. ^{1}HNMR, UV/Vis, and Thin Layer Chromatography (TLC) were used in analyzing and indentifying the target compound. ^{1}HNMR and UV/Vis spectra were excellent methodologies in comparing the target compounds to the starting material, pyropheophorbide-a. ^{1}HNMR spectrum of t-butoxy carbonyl methoxy pryropheophorbide-a confirmed the presence of all organic compounds of pryropheophorbide-a, which explained the structure of pyropheophorbide-a didn't undergo degradation while adding different reagents to it.

The objective of synthesizing methoxy L-lysylpyropheophrbide and its metal Zn II is to investigate whether the target compound of pyropheophorbide-a can be an excellent photosensitizer in treating cancer and other serious diseases.

Entry Number: 95 UL

NITRITE REDUCTASE ACTIVITY OF GLYCATED HEMOGLOBIN

By: Damon Robles and Kay Saw
Chemistry
Faculty Advisor: Dr. Raymond Esquerra

Abstract: Diabetes is a leading cause of mortality and morbidity worldwide, with the number of people who suffer from this disease expected to increase. Diabetics have an elevated risk of cardiovascular dysfunction. The relationship between elevated blood sugar levels and increased cardiovascular complications is unresolved. Recent evidence shows that hemoglobin acts as a nitrite reductase, reducing nitrite to nitric oxide (NO) and contributing to vasodilation under hypoxic conditions. To determine the effect of glycation on the nitrite reductase activity of hemoglobin, we compared the nitrite reductase activity of non-glycated hemoglobin (HbA0) to the nitrite reductase activity of hemoglobin with a covalently linked sugar, HbA1c. We find that HbA1c has increased nitrite reductase activity compared to HbA0 and explore the molecular basis for this difference, primarily focusing on differences in allostery. Understanding how glycation alters normal nitric oxide physiology is fundamental to designing therapies that will reduce cardiovascular dysfunction in diabetics.

Entry Number: 96 UL

RAPID IDENTIFICATION OF COUNTERFEIT DRUGS VIA X-RAY FLUORESCENCE SPECTROMETRY

By: Heather Gregory and Charlie Bupp
Chemistry
Faculty Advisor: Dr. Pete Palmer

Abstract: Due to the widespread propagation of counterfeit drugs, there is an urgent need for new analytical methods for rapid assessment of the quality and authenticity of these products. Many of the "gold standards", such as GC/MS, or LC/MS, used for reliable identification of drugs and pesticides would be appropriate. However, though all of these are capable of multi-element analysis, and have low detection limits, none of these aforementioned techniques are appropriate for fieldwork , as both are desktop units rather than handheld. In addition, neither technique produces results in an appropriate amount of time, as FDA investigators and other agents need to analyze great quantities of product, in a relatively short amount of time. Furthermore both techniques require a great deal of sample preparation, something that should preferably be minimized when dealing with bulk quantities of suspect drugs. X-Ray Fluorescence Spectrometry (XRF) is a fast, nondestructive, multi element analysis technique suitable for this purpose. In this study, a new research-grade, field portable XRF analyzer, a Bruker Tracer III SD, will be utilized for the analysis of the elemental composition of different suspect and authentic erectile dysfunction (ED) medications (ViagraTM, LevitraTM, and CialisTM) as well as other adulterated drug and food products(i.e. pomegranate juice, etc). It's limits of detection are on the order of 1-100ppm, and is capable of multiple element analysis from Na to U. Analysis will be performed under optimized current, voltage, vacuum, and filter source conditions to provide more efficient excitation and fluorescence of different elements and hopefully derive better data to enable differentiation of authentic and counterfeit products. In addition, samples will be analyzed both "as is" and homogenized, in order to derive the best data possible. Potentially, the packaging of these authentic and suspected counterfeit drugs may also be analyzed to determine if there is a discernable difference between the inks used, watermarks, etc. Differences between authentic and suspected counterfeit spectra will be evaluated in a variety of ways, including visual inspection and Principal Component Analysis(PCA). The resulting spectra will contribute to the generation of libraries of XRF spectra of authentic drugs, which can be used for quick comparison in future drug analyses.

Entry Number: 97 UL

Fe ANALYSIS OF BEER VIA HAND HELD XRF USING CATION EXCHANGE RESINS

By: Matthew Sanchez
Chemistry
Faculty Advisor: Dr. Pete Palmer

Abstract: A field method was designed to test the Fe concentration in Beer Via Hand held XRF. Direct analysis of a beer sample via XRF was not possible because the concentration of Fe in beer is below the LOD of the XRF instrument. This was overcome by concentrating the sample by using a cation exchange resin. Parameteres such as a resin mass, pH, and resin mixing time were optimized.

Entry Number: 98 UL

PROTEIN DYNAMICS USING COMPUTATIONAL CHEMISTRY APPROACH. STRUCTURAL FEATURES OF THE WILD TYPE SERINE PROTEASE

By: Shi Choong
Chemistry
Faculty Advisor: Dr. Anton Guliaev

Abstract: Recent progress in computer simulations provides reliable structural insights into the conformational features of the biological molecules. These computational improvements include accurate treatment of the electrostatic interaction (particle-mesh Ewald method), utilization of the explicit solvent with counter ions, improved force field parameters and implementation of the polarization factors. Molecular dynamics (MD) simulation is one of the computational techniques used to study the structures and microscopic properties of biomolecules based on experimental parameters and Newtonian mechanics. Therefore MD simulations could

act as a bridge between theory and experiment, and permit detailed structural studies of complex biological molecules that are difficult or impossible to elucidate using standard experimental techniques.
The goal for this work was to employ MD simulations to investigate conformational features of the wild type trypsin. Trypsin is one of the three principal digestive proteinases found in both vertebrates and invertebrates, including humans. In this work, we employed unrestrained MD simulations with explicit solvent using AMBER force to sample conformational space for this protein in aqueous solution. The main focus for our conformational analysis was the catalytic triad of the trypsin: Ser 195, His 57 and Asp 102, and C42-C58 disulfide bridge found near the enzyme active site. The detailed dynamic data obtained in this work will be the basis for the future studies of the trypsins' structural variants.

Entry Number: 99 UL

A CONTRIBUTION TO THE FIGHT AGAINST CANCER: SYNTHESIS AND CHARACTERIZATION OF LYSINE-SUBSTITUTED PHEOPHORBIDE-A IN THE QUEST FOR A SUPERIOR PHOTOSENSITIZER

By: Viviana Cervantes
Chemistry
Faculty Advisor: Dr. Uschi Simonis

Abstract: The quest for a superior photosensitizer is imperative for further developing photodynamic therapy (PDT) as a clinically-feasible modality in the fight against cancer. In pursuit of this quest, lysine-substituted pheophorbide-a (LysPh-a) was synthesized. In a common peptide-coupling reaction, pheophorbide-a (Ph-a), a chlorin derivative recognized for its photodynamic properties, and Nε-(tertbutoxycarbonyl)-L-lysine methyl ester were reacted in the presence of the coupling reagents 1-hydroxybenzotriazole hydrate, 4-dimethylaminopyridine, N,N'-di-isopropylethylamine, and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride. Deprotection of the tertbutoxycarbonyl group (Boc) was achieved with HCl/dioxane. To test if LysPh-a revealed properties of an improved photosensitizer, the wavelength of the 4th Q band in the UV/visible spectrum, water-solubility, tendency to aggregate, and purity were determined. The UV/visible spectrum revealed a Soret band at 407 nm, and four Q bands with absorption maxima at 505 nm, 536 nm, 608 nm, and 665 nm. Of the four Q bands, the 4th Q band which is used for the photosensitizing process had the largest extinction coefficient with absorption maximum at 665 nm. The compound dissolved in acetone, methanol, and water.1H-NMR spectroscopy confirmed that the coupling reaction successfully led to the attachment of lysine. This was confirmed by the appearance of four CH2 multiplets resonating at 2.0-2.9 ppm which is characteristic for lysine. The Boc singlet peak at 1.4-1.6 ppm did not appear, thus confirming that deprotection was successful. As a result of the success LysPha-a synthesis, further research on phototoxic properties can be conducted. To determine if the insertion of a metal ion into the Ph-a macrocycle improves phototoxic properties, LysPh-a will be metallated with In(III)chloride. Synthesizing and characterizing compounds, such a LysPh-a, that reveal promising properties of superior photosensitizers will vastly increase the availability of PDT candidates for FDA approval, thereby enhancing the likelihood that PDT will be successfully used in the fight against cancer.

Entry Number: 100 UP

WOODBRIDGE DESIGN

By: Reza Hashemzade, Alisina Oshaghi, Joey Aduviso, Jose Garcia, Leyla Pirnia, and Cristina Aragon
Civil and Environmental Engineering
Faculty Advisors: Dr. Timothy D'Orazio and Dr. Cheng Chen

Abstract: Our intent when planning our bridge was to create a unique and elegant design, without sacrificing strength and efficiency. Though the concept of the arch in nothing new, we've incorporated the K-truss into the design and made it an understructure in order to manufacture a more exclusive bridge. Our original three under-arch truss design built from smaller sections of timber was inefficient when limiting deflection in the center of the bridge. Instead, a four under-arch truss, made of 32 sections of plywood glued together, increased the stiffness of the frame and limited the deflection.The understructure consists of four under-arch trusses fabricated sheathing plywood. Each truss is composed of four layers ¾ inch plywood sections, accounting for a total of eight sections per truss. The sections were cut out using a life-size outline, and staggered at the center.

Before assembling each truss, the sections were laid flat and cleaned with a brush. A coat of Titebond II Wood glue was applied to each layer before placing the sections together. Once in place, the sections were nailed through their entire length, to prevent any sliding while being handled, and tightly clamped. Each under-arch was then left clamped over the next three days in order for the glue to cure under pressure. Once the clamps were removed, three tie plates were attached at the center using 1/2 and 3/8 inch in. diameter steel rods to resist any shear force that might occur between the staggered sections. Twenty-one transverse pieces of 2x6 in. posts were used between the four under-arches at seven points along the length of the bridge. Originally, the understructure was to consist of K-bracing posts down the span of the bridge. However, due to limited spacing, the design was changed to single transverse sections, providing lateral support to the understructure to avoid buckling from torsion. This new design also reduced the weight of our bridge by a substantial amount. To attach the transverse sections to the four under-arches, we used both commercially available joist hangers, to connect the outer trusses, and 5 in. screws, to connect the inner trusses. The horizontal posts consisted of four 4x4 posts down the length of our structure. However, rather than resting the posts on the four under-arches, we fastened them to the understructure. Using threaded rods with washers and nuts, both L-shaped and T-shaped plates were connected down the sides of each post at seven different locations. Finally, our deck was assembled from twenty-eight 2x6in Mendocino Construction Heart redwood planks resting transversely on top of the horizontal posts, with sixteen screws through each deck panel of the bridge.

Entry Number: 101 UP

FOUNDATION DESIGNS

By: Abdirahman Adam, Jennifer Smith, Jennifer Tran, Johnny Hoang, Wubet Woldemichael, and Yue Ming Huang
Civil Engineering
Faculty Advisor: Dr. Timothy D'Orazio

Abstract: For our project, our group of engineers is responsible to design multiple options of foundation designs to withstand the structure load requirement that were asked for. The structure's load of 100,000 kips with the dimensions of 200 feet by 200 feet will be designed with the following options: mat, footing, friction piles, and ended bearing piles with combination of reducing the space of columns, preloading, wick drain, and adding a basement. Each option will give a slight difference of strengths and settlements. It is our job to provide the best and most cost efficient foundation designs possible.

Entry Number: 102 UP

SFSU TIMBER TRUSS BRIDGE

By: Alex Osorio, Noor Hasan, Patrick Ledesma, Chor Sum Wong, George Khaelilieh, and Hamed Khan Zadran
Civil Engineering
Faculty Advisor: Dr. Cheng Chen

Abstract: For our senior design project we designed, constructed and loaded a bridge to enter the 2010 ASCE/FPS National Timber Bridge Design Competition. In doing this we intended to gain experience with realistic design constraints, using wood as an engineering material, project management, and to do well in the competition. Our 4.0 x 1.4 meter bridge consisted of a simple frame, made up of six longitudinal beams and six rows of staggered transverse diaphragms. Two Pratt trusses are attached to the outside longitudinal beams. The deck consisted of transverse 2 x 8's connected by two joist hangers that are screwed into the frame. After one hour at the full load of 20 kN our bridge had deflected 6.68 millimeters at mid-span, approximately 70% of the maximum allowable deflection, while the net deck deflection was 2.20 millimeters, 96% of its maximum allowable deflection. Out of 11 teams competing in this year's competition, our team was awarded 1st place in the Most Practical Design category.

Entry Number: 103 UP

ENGR697 GEOTECHNICAL GROUP #4

By: James O'Connell, Joshua Tse, Colby Lum, Tony Cheung, and Nik Favretto
Civil Engineering
Faculty Advisor: Dr. Timothy D'Orazio

Abstract: Our project will entail the analysis and design phases of the construction of a foundation for a building. Our goal is to analyze the soil properties of a pseudo-plot of land in-order to uncover the types of failures that our potential building could succumb to throughout its life. The second phase of our project is to design the foundation of our building, taking into consideration the soil properties that we had previously analyzed. The end result will contain the best case scenario (including economic, environmental, and many other factors) in terms of foundation types for our building and cost analysis of our project.

Entry Number: 104 UP

CONCRETE CANOE

By: My-Linh Nguyen, Christine Hunt, Nick Kim, Lindsay Green, Eoin Sheeran, Alvin Piano, James Esoimeme, Jose Preciado, and Julie Leong
Civil Engineering
Faculty Advisors: Dr. Cheng Chen and Dr. Timothy D'Orazio

Abstract: A concrete canoe was constructed to participate in the 2010 American Society of Civil Engineering Mid-Pacific Conference

Entry Number: 105 UP

NATIONAL STUDENT STEEL BRIDGE COMPETITION

By: Samuel Fitzer, Chris O'Gara, Chris Pioli, Jonathon Tai, Marissa Silvas, John Crain, Julian Jaramillo, Nadia Berumen, Lester Aquino, and Cindy Lu
Civil Engineering
Faculty Advisor: Dr. Cheng Chen

Abstract: The 2010 National Student Steel Bridge Competition (NSSBC) is an annual civil engineering competition where each university has the opportunity to compete in the engineering design, fabrication, construction, and testing of a model steel bridge. This year the competition is based on a hypothetical request from Boreal Energy Corporation; a fictional company that desires to construct a new oil field in the arctic tundra. Boreal Energy Corporation is accepting bids for a design-build contract to erect a steel bridge in order for the corporation to transport necessary materials to the oil field construction site. The bid process includes the presentation of a poster board and a 1:10 model of the steel bridge. The model span must be between 19-21 feet and will be subject to a vertical load of 2,500 lbs and a lateral load of 50 lbs for deflection testing. The model is judged during the competition on construction speed, construction economy, aesthetics, stiffness, weight, structural efficiency, and overall performance. The model steel bridge is judged and tested against 8 other school model bridges in a Mid-Pacific regional student
conference.

Entry Number: 106 UP

BIORADICAL BIOSAND FILTER: AN IMPROVED PERFORMANCE DELIVERY SYSTEM FOR SAFE DRINKING WATER

By: Steven Chua, Gloria Fernandez, David Dip, Chris Kekicheff, and Diana Loie
Civil Engineering
Faculty Advisor: Dr. John Dracup

Abstract: In Kolkata, India, 1.6 million people die every year from diarrheal diseases due to the lack of safe drinking water caused by crowding, poor sanitation, and highly contaminated water sources. As a result, there is a need for end users to have control and access to safe drinking water. This paper is a development of biosand filters as a technology delivery system to provide safe drinking water for developing communities. Yet, a limitation of current biosand filter (BSF) technology is the time it takes for the biological layer to mature in order to ensure safe drinkable water comes out of the filter. This can take between three weeks to a month for

the biolayer to develop. Using locally accessible ingredients, recipes were added as another component to the sand layer in the biosand filter system in hopes of reducing the wait time for the biolayer to mature. The research done for this system shows that the addition of limestone vastly improves the effectiveness of the BSF at removing contaminants. In addition to improving the performance of this technology, an implementation system is integrated into the overall delivery system of this technology. Water quality analyses, participation in a biosand filter workshop, cost-benefit, and life cycle assessments; along with engineering systems analyses of the public, government, industry, and the environmental sector, show that the BRC provides a viable solution in providing access to safe drinking water and sanitation to cities such as Kolkata, India.

Entry Number: 107 UP
2010 NATIONAL TIMBER BRIDGE COMPETITION
By: Tony Tam, Shiu Mak, Kakiu Ching, Ailin Liu, Jiayi Fu, Nicole Salde, and Shu Feng Yu
Civil Engineering
Faculty Advisor: Dr. Cheng Chen
Abstract: Our focus was the 2010 National Timber Bridge Design Competition. The competition required that each team design, build and test a bridge constructed from wood structural members. Although the main goal of any competition was to win or place in any of the award categories, our main goal was to design and construct a fully functional model timber bridge within the confines of the 2010 rule set.

Entry Number: 108 UP
CARDIO VEST
By: Jose Emerson Malca Gutierrez and Hemel Yahya
Computer Engineering
Faculty Advisor: Larry Klingenberg
Abstract: The Cardio Vest is a medical device used to train nurses to detect heart anomalies based on heart sounds. It is design to reproduce

Entry Number: 109 UP
PROJECT R.A.M.T.A.P.
By: Shawn Yee
Computer Engineering
Faculty Advisor: ??
Abstract: Project RAMTAP (remote access monitor temperature acquisition program) solves the costly problem of remotely monitoring the temperature of a room or device. The project involves the hardware for temperature acquisition and the software for capturing and displaying the data numerically and graphically on a website.

Entry Number: 110 UP
HYBRID RADIO CONTROL CAR
By: Andy Kwan and Richard Solomon
Electrical Engineering
Faculty Advisor: Dr. Tom Holton
Abstract: Designed radio control car that switches power from solar power and battery power automatically with user indication.

Entry Number: 111 UP
WIRELESS TEMPERATURE DISPLAY AND CONTROL SYSTEM
By: Billy Hui and Aung Tint
Electrical Engineering
Faculty Advisors: Dr. Tom Holton, Dr. George Anwar, and Dr. Hao Jiang
Abstract: To design a wireless temperature sensing and control system with 2 main individual parts.
To build a wireless temperature transmitter with temperature sensor, microcontroller and transmitter module;

To build a wireless temperature receiver with receiver module, microcontroller and serial/4 7-segment LCD display output temperature (digital).
To design a wireless set-point device to choose any temperature number as the users desire.
To Compare both analog temperature and set-point signals to decide the temperature go up and down.

Entry Number: 112 UP
MOUSE
By: Farah Soltane and Thomas Pedersen
Electrical Engineering
Faculty Advisors: Mutlu Ozer and Dr. Tom Holton
Abstract: It's a computer game

Entry Number: 113 UP
AN EXTERNALLY CONTROLLED MAGNETIC DISC SCREW DEVICE
By: Fersan Winardja and William Diep
Electrical Engineering
Faculty Advisors: Dr. Tom Holton, Dr. Kwok-Siong Teh, and Dr. Hao Jiang
Abstract: Our project is consisted of utilizing rare-earth magnetic disc quality to determine the unique property of magnetism and to use the magnetic discs as an externally controlled device. This prototype will be able to find the force that acting on the discs and to discover its potential. This device can be implanted as bio medical device in a patient with the multiple scoliosis. It purposes is to be able to change the length of the bone without the need of another operation. Eventually such a device will be implemented in the future by doctors.

Entry Number: 114 UP
RCL METER
By: Hezekiel Randolph
Electrical Engineering
Faculty Advisor: Dr. Tom Holton
Abstract: The USB TestBench project serves as a basis for measuring and controlling electronics for the rapid prototyping purposes of hobbyists and engineers.

Entry Number: 115 UP
AUDIO SWITCHER
By: John Laberinto, Cassidy Louie, and Jeff Constantino
Electrical Engineering
Faculty Advisors: Dr. Tom Holton and Dr. Hao Jiang
Abstract: Audio Switcher which will be able to cycle through four audio inputs.

Entry Number: 116 UP
SEARCH ROVER
By: Michael Arce, David Chin, Cianan Duncan, Javier Fernandez, and John Wudyts
Electrical and Mechanical Engineering
Faculty Advisor: Dr. Kwok-Siong Teh
Abstract: The collapse of buildings or other structures due to accident, natural disaster, or attack sometimes creates conditions that are inconvenient or impossible for search and rescue workers to enter. To this end we, for our senior project, propose creating a small robot that could enter rubble in place of a human or a dog to search for survivors. The robot would be able to survive conditions that would be potentially hazardous to humans or working animals and could also allow operators to perform structural assessments of the interior. The robot is to be small enough to enter rubble and durable enough to survive the conditions it so encounters.

Entry Number: 117 UP

MIDI ACTUATED ROBOTIC VIBRAPHONE

By: Tim O'Keefe, Brock Roland, and Michael McIntyre
Electrical and Mechanical Engineering
Faculty Advisors: Dr. Tom Holton and Dr. Ed Cheng

Abstract: A mechatronic attachment has been designed for an existing musical instrument, the vibraphone (Ref Figure 1). This attachment consists of two solenoids for each of the instrument's 37 resonating bars: 37 striking solenoids for actuating the sound, and 37 damping solenoids for damping the sound. These solenoids have been attached to three removable assemblies that place them in the appropriate locations on the instrument when installed. Each solenoid is fitted with a custom head to produce the correct sounding and damping characteristics when actuated. The mechanical assemblies are attached to three printed circuit boards (PCBs), each of which is fitted with an Atmel ATMEGA16 microcontroller, along with power electronics for 13 striking solenoids and 13 damping solenoids. The Atmel chips are each programmed with custom software to read input from a standard computerized musical communication protocol known as MIDI. Another custom circuit board conditions the MIDI signal from other MIDI enabled devices, such as a musical keyboard or a personal computer. Three power supplies are also included to provide 48V for the striking solenoids, 12V for the damping solenoids, and 5V for the MIDI board and microcontroller logic needs. The electronics are encased in a portable, waterproof briefcase with ports for connections to the mechanical assemblies, controlling MIDI devices, and typical 110VAC power.

Entry Number: 118 UP

MECHANICAL PHOTOSENSORY PATIO UMBRELLA

By: Salim Saikaly, Laith Alawad, and Muataz Hamad
Mechanical and Electrical Engineering
Faculty Advisors: Larry Klingenberg and Dr. Tom Holton

Abstract: Build a photosensory, electric powered Patio Umbrella to provide shade on a specific area.

Entry Number: 119 UP

RACE CAR

By: Andrew McBrian Cole, Kayvon Shakeri, Kevin Gee, and Prasith Sip
Mechanical Engineering
Faculty Advisor: Dr. Kwok-Siong Teh

Abstract: We took on the task of building a race car for our senior project. This required the team to implement their understandings of disciplines in the areas of structural analysis, fluid mechanics, thermo dynamics, etc. In the process we learn to set up a working area and used many different types of tools to complete the project. Good communication and team working skills were also developed during this project. Our end goal is to compete in the 2010 SCTA race season.

Entry Number: 120 UP

DRINK MIXER

By: Andrew Navarro and Christian Fernandez
Mechanical Engineering
Faculty Advisor: Dr. Tom Holton

Abstract: Our project is called the Drink Mixer. The goal of our project is to design a device that will dispense two different liquids at a ratio set by the user. We have incorporated the use of a microcontroller along with solenoid valves and pressure sensors to accomplish our goals. We also used our knowledge of fluid mechanics, process control, and computer programming in designing our project.

Entry Number: 121 UP

AUTOMATIC BASKETBALL RETURNER

By: Brandon Leaupepetele and Hieu Vo
Mechanical Engineering
Faculty Advisor: Dr. Dipendra Sinha and Dr. Kwok-Siong Teh

Abstract: For our senior project we have proposed to design and build an automatic basketball returner prototype. We set two Goals. Our first objective is to design and build a mechanical system that will return the basketball to the user after a made shot. This system must be able to rotate 180 degrees and must be controllable. Our second objective is to control the direction the ball will be returned--i.e. angular postition. This is a two mode objective. For Mode 1 the returner will rotate after every made basket to either fixed or random positions. For Mode 2 the returner will constantly follow the angular postion of the player. To do this we will be using a CMUcam for our sensor. The CMUcam locates the centroid of a color blob which the user sets. The completion of objective 1 and Mode 1 will be considered a success although we hope to complete Mode 2 as well.

Entry Number: 122 UP

CLOSED-LOOP FEEDBACK CONTROL OF A HIGH FREQUENCY INDUCTIVE HEATING SYSTEM FOR NANOMATERIAL SYNTHESIS

By: Curtis Hilger and Joachim Pedersen
Mechanical Engineering
Faculty Advisor: Dr. Kwok-Siong Teh

Abstract: A high frequency inductive heating system is used to heat a nickel process chip to temperatures reaching up to 1200 degrees Celsius. A custom built microcontroller driven circuit has been built to control the output of a 13.56 MHz power supply, while another dedicated microcontroller circuit has been built to measure environment variables within the process tube including: process chip temperature, tube pressure and plasma ignition. The individual sub-systems are connected to a PC workstation running LabView 2009. Several specialized LabView applications have been written in order to configure, characterize, control and audit the response the inductive heating process. Adaptive closed-loop feed back control of the heating process is possible to within plus or minus 1 degree C steady-state, within a temperature range of 0-1200 degrees C.

Entry Number: 123 UP

ZINC-CATALYZED, RAPID SYNTHESIS OF ULTRA LONG SILICA NANOFIBERS BY

By: Joachim Pedersen
Mechanical engineering
Faculty Advisor: Dr. Kwok-Siong Teh

Abstract: We present a method for rapid synthesis of SiOx nanofibers on a superheated Si(100) surface at high pressure. Using a high frequency inductive heating device we are able to reach a process temperature and complete growth in 5 minutes. Nanofibers diameters range 20-200nm, and grow at 10-50μm/minute.

Entry Number: 124 UP

POWERED LAZY BOY

By: John Wudyts, Shifteh Einollahzadeh, Andrew Damele, Jeremy Martinez, Haris Alijagic, Laith Alawad, Hemel Yahya, and Emerson Malca
Mechanical Engineering
Faculty Advisors: Dr. George Anwar and Dr. Dipendra Sinha

Abstract: This project's goal is to enhance ones leisure experience. To this end we, for our Materials and Manufacturing process's and our Mecatronics class, propose creating a powered drivable lazy boy recliner via an application which can be uploaded to either an iPod Touch, iPhone, and even the iPad. The Chair will be powered by two electric motors which deliver 2/3 horsepower and is fully rechargeable. Enabling the user to effortlessly drive throughout their hows in the comfort of a lazy boy.

Entry Number: 125 UP

VERTICAL AXIS WIND TURBINE

By: Rochelle Desamito, Judith Krischke, and Richard Wang
Mechanical Engineering
Faculty Advisor: Dr. Kwok-Siong Teh

Abstract: Designing, building, and testing a vertical axis wind turbine to see the economics of a small scale wind turbine in the bay area as well as seeing how well practice follows theory in terms of power generation.

Entry Number: 126 UP

SWITCHABLE V.O./V.C. PROSTHETIC HAND

By: Timothy Sullivan, Nicolas Dibenedetto, and Gandiva Moss
Mechanical Engineering
Faculty Advisor: Dr. Kwok-Siong Teh

Abstract: There are two main types of body power prosthetic hands: Voluntary opening and voluntary closing; however, there are not many prosthetics that combine both modes oof operations. The models currently available on the market do not work well, and for that reason we have designed and constructed a new prosthetic that we beleive may offer advantages over existing designs.

Entry Number: 127 UP

THIN FILMS OF IRON II DISULFIDE (PYRITE) FOR PHOTOVOLTAIC APPLICATIONS

By: Diana Mars
Chemistry
Faculty Advisor: Dr. Andrew S. Ichimura

Abstract: Photovoltaics (PV), or solar power, is the generation of voltage at the interface of two materials that are exposed to light. Pyrite, a semiconductor with a low band gap (0.95 eV) and broad spectral absorption, is made from abundant and nontoxic iron and sulfur, making it attractive as a photovoltaic component. In this work, we explore low temperature aqueous phase solution chemistry for the growth of pyrite thin films. Furthermore, we hypothesize that the surface texture and uniformity of film growth can be guided by self-assembled monolayers (SAMs) when utilized as an interfacial layer.

Pyrite films will be grown on Au(111) substrates functionalized with self-assembled monolayers (SAMs) of alkane thiols and aromatic thiols. Au(111) substrates 200 nm thick will be prepared by evaporation under high vacuum. The expected Au(111) texture will be confirmed by x-ray diffraction (XRD) and grain size will be measured with scanning electron microscopy (SEM). SAMs will be grown in ethanolic solution at room temperature and SAM quality – structure, two dimensional order – will be determined with reflectance Fourier Transform Infrared spectroscopy (FTIR). Pyrite films will be synthesized from equimolar ferrous sulfate and thiosulfate with excess elemental sulfur. XRD and SEM will be employed to examine crystal size, morphology and orientation.

Our goal in this work is to prepare polycrystalline single phase pyrite films with tunable thickness and morphology that spans the width of the substrate if allowed to react for a sufficient period of time at 150ºC.

Entry Number: 128 UP

VISIBLE-WAVELENGTH INTEGRATED SPECTROSCOPY OF BINARY ASTEROIDS

By: Abigail Elisabeth Reiss
Astrophysics
Faculty Advisor: Dr. Adrienne Cool and Dr. Franck Marchis

Abstract: Binary asteroid systems consist of two small planetary bodies orbiting a common center of mass. To date, approximately 65 systems have been imaged using Hubble Space Telescope observations and various techniques, such as adaptive optics and radar imaging methods. An additional 120 binaries are suspected to exist based on light curve analysis and new discoveries are being announced every month. One important task involved in the study of these systems is the classification of their surface mineralogy. The compositional characterization of asteroid surfaces requires observations across a wide wavelength range. A number of

rigorous classification methods have been used to group asteroids into classes based on their observed characteristics. Most recently, a feature-based taxonomy was developed by Bus and Binzel [Bus S. J. and Binzel R. P. (2002) Icarus 158, 146–177]. Bus and Binzel decomposed the visible-wavelength (0.44 – 0.92 μm) spectra of asteroids into three major groups—complexes C-, S-, and X-. Each complex was then further refined into 26 sub-classes associated with distinct mineralogical surface features. Using the Shane 3-meter telescope at Lick Observatory, we observed twelve binary asteroid systems with the KAST double spectrograph. The primary observations were conducted on three nights between May and July of 2009 as a part of an observation program to complete the Virtual Observatory Binary Asteroids Database (VOBAD). The spectrograph at the Shane telescope provides wavelength coverage between 0.3 and 1.0 μm using both blue (0.3-0.57 μm) and red (0.53-1.0 μm) channels, with each spectrograph optimized for its wavelength range. Using this instrument, we obtained a comprehensive measurement of our targets' visible spectra, exceeding the wavelength range over which Bus and Binzel taxonomy is based. From the obtained visible-wavelength spectra, we were able to determine the spectral types of six previously unclassified binary asteroids.

Entry Number: 129 UP

BEAM REFLECTION BY NEGATIVE DEFECTS IN PHOTONIC LATTICES

By: Alexandra Miller
Physics
Faculty Advisor: Dr. Zhigang Chen

Abstract: We demonstrate both theoretically and experimentally that a beam can be reflected by a negative defect in photonic lattices if the incident angle is below a threshold. This phenomenon can be used to control beam propagation in photonic lattices.

Entry Number: 130 UP

NON-CRYSTALLINE PHOTONIC BANDGAP MATERIAL STUDY

By: Kazue Matsuyama and Polin Yadak
Physics
Faculty Advisor: Dr. Weining Man

Abstract: Photonic band gap materials prevent photons with certain frequency propagating inside them. Their ability to confine and control electromagnetic waves makes them useful for telecommunication, quantum computing, solar cells and other fields. Conventional crystalline photonic bandgap materials have limited rotational symmetry and different periodicity in different directions, which makes it hard to get complete photonic bandgap in all directions. We design and fabricate non-crystalline photonic bandgap material and use microwave transmission experiments to characterize their photonic properties. We report the world's first experimental demonstration of photonic bandgaps (PBGs) in 2D hyperuniform disordered materials and show that is possible to obtain isotropic, disordered, photonic materials of arbitrary size with complete PBGs. These results open a brand new avenue for designing photonic bandgap materials." We report the first experimental demonstration of photonic bandgaps (PBGs) in 2D hyperuniform disordered materials and show that is possible to obtain isotropic, disordered, photonic materials of arbitrary size with complete PBGs.