Neven Abdo  
*Professor Mimi Phan*  
The Effect of Hormonal Manipulation on Parental Behaviors Elicited by Offspring Vocal Cues

Zebra finches (ZF) are socially monogamous birds that mate for life, sharing nesting and offspring rearing duties. Studies show that hormones are released by social and parental experiences. Oxytocin is a hormone responsible for maternal behavior and vasopressin is a hormone responsible for paternal behavior, in mammals. This study addresses the question: how do the hormones mesotocin and vasotocin, avian hormones involved in social behaviors and analogous to oxytocin and vasopressin (respectively), affect parental behaviors in birds? We previously found that there are differences in the neural processing of and behavioral responses to fledgling begging calls in parental and virgin adult ZFs, of both sexes. The current experiment tested whether mesotocin and vasotocin, can increase behavioral and neural responses in male and female virgins ZFs. Video scoring was used to assess the effects of hormonal manipulations on behavior. Two quantitative datasets, the amount of bird chirps in response to the fledgling calls and how much time the bird spends inside the nesting area during fledgling call playback, were recorded and analyzed to understand the differences in behavior between the hormonally-treated and control animals. Results indicate that sex and hormonal treatment didn’t have an effect on the amount of time subjects spent in the nest area. However, results indicate hormone treatment did have an effect on the call responses in females and males. Hormonally treated subjects called back to fledgling begging calls less frequently than controls. This result was unexpected and suggests more experimentation be done to assess effects of dose and place of injection on these behaviors. Other future directions of study involve injections of antagonists of these hormones to parentally-experience ZFs to explore whether their parental behaviors can be extinguished.

Chanchal Agrawal  
*Professor Qian Cai*  
Regulation of BACE1 Through the Autophagy Pathway

Alzheimer's disease (AD) is the most prevalent type of dementia that results in impairment of cognitive abilities and loss of memory. One of the pathogenic hallmarks of AD is the accumulation of amyloid plaques in which amyloid-b (Aβ) peptide is the primary constituent and is derived from a series of proteolytic cleavage of amyloid precursor protein (APP). β-site APP-cleaving enzyme 1 (BACE1) is the major β-secretase responsible for cleaving APP to generate Aβ. Previous studies have shown that autophagy, a major cellular quality control pathway, is essential for the maintenance of neuronal homeostasis and that its alteration is closely correlated with AD pathology. However, its precise effects on BACE1 and its processing of APP are largely unknown. In this study, we research to determine how BACE1 is regulated in response to autophagy induction. After treating primary cortical neurons with an autophagy inducer and performing sequential immunoblots, we reported that autophagy induction reduced BACE1 levels in wild-type cortical neurons, suggesting that autophagy controls BACE1 turnover. Conversely, neurons cultured from mutant human APP transgenic mice displayed significant accumulation of BACE1 under the same treatment, which is coupled with enhanced APP amyloidogenic processing. We proposed that enhanced autophagy augments BACE1 processing of APP in AD neurons. Future investigations will be focused on the
mechanism underlying autophagy-mediated regulation of BACE1 trafficking and turnover, and its impact on amyloidogenesis in AD brains.

Abhishek Arya
Professor Jason Grabosky
Developing a Script to Help Foresters Make Better Land Management Decisions

The NJ Sate Forest Service is responsible for managing state owned forested lands such as state parks, forest, etc., and make management decisions based on the data they collect. For the health and value of forests in the north eastern U.S., they must take into account climate change, novel diseases and pests, and the impacts of such things on the growth and resilience of the forest community. A lot of their work involves collecting data about these forests and then running simulations on these forests using two programs, the Forest Vegetation Simulator (FVS) and ArcGIS. These two programs take in tables of data as the input, and then show simulations of the forest based on the data. The programs can forecast what the forest will look like after decades, what it will look like years after disturbances and management activities such as a wildfire, a timber harvest, etc. However, these two programs are not able to communicate and share the data tables they output. Therefore, we decided to create a program to allow the two to communicate and share the data they use. We are coding the script in in a language called Python, and are using the OpenPyxl library and the ARCGIS library. The OpenPyxl library allows us to work with the data in excel spreadsheets, also known as xlsx files. The ArcGIS library is the set of methods that the ArcGIS program uses. This script automates an otherwise tedious process and reduces the number of potential errors in the data. We will continue to make the script more efficient and add more functionality to it, and make it available to the forest managers around the country as well. The feedback from the NJ foresters has been positive so far, and our expectation is that once the tools are developed, both researchers and practitioners will improve their skills and abilities to more fully deploy the simulation tools for better forest management.

Sushuptha Balakrishna
Professor Eileen White
Metabolomic Alterations in an Autophagy Deficient Mouse Model of Neurodegeneration

Autophagy is the process of recycling intracellular components to sustain cellular metabolism during stressful conditions to preserve cell maintenance and survival. Autophagy substrates include cytoplasmic organelles, proteins, and macromolecules. In a previous study titled “Autophagy is required for Glucose Homeostasis and Lung Tumor Maintenance”, autophagy is shown to be linked to antitumor activity during tumor maintenance. Using autophagy deficient mouse models, tumor growth was blocked during tumor expansion due to promotion of cell death, which led to a more benign disease in mice with preexisting lung cancer. Therefore, autophagy is upregulated in tumor cells to help them survive and maintain homeostasis, which supports that autophagy deficient conditions correspond to antitumor activity. On the other hand, deficiency in a metabolic pathway can contribute to lethality. Mice with acute autophagy deletions showed muscle wasting, liver damage, hypoglycemia, ataxia, etc. And most of the mice died from neurodegeneration. When autophagy is absent, proteins and molecules won’t be recycled in the neurons in the brain. This could result in presynaptic accumulation of ubiquitin proteins and inclusion bodies, resulting in degeneration of the dendrites, as well as dystrophic terminals and axons, eventually leading to phenotypes of neurodegeneration. This project focuses on detecting early signs of neurodegeneration through analyzing and comparing changes in cellular metabolism between neurodegenerative mice and wild type mice. The findings could potentially help catch early signs of brain diseases in humans.
Sophia Blanc  
*Professor Nicole Fahrenfeld*

**Impact of a Green Disinfectant on Antibiotic Resistance Genes in Combined Sewer Overflows**

Increasing rates of antibiotic resistant infections have highlighted the need to understand environmental sources behind these infections, including antibiotic resistance genes (ARGs) in water. Wet weather and combined sewer overflows have been identified as sources of ARGs in urban waterways. The purpose of this study was to test an environmentally friendly disinfectant’s ability to inactivate antibiotic resistant gene-carrying bacteria and to destroy ARGs in combined sewer overflow effluent. A combined sewer system collects wastewater and wet weather runoff. A combined sewer overflow occurs during times of heavy influent volume, like storms, and releases untreated storm and wastewater back into the environment. Because the overflow bypasses treatment, ARGs found in bacteria flow directly into bodies of water. In this study, simulated combined sewer overflow effluent was treated with peracetic acid, a green disinfectant which does not produce disinfection byproducts. A viability-based qPCR assay was performed for select ARGs to reveal how many total ARGs and ARGs in viable cells (defined as cells with intact membranes) remained after treatment. Results of this study may help inform mitigation strategies for antibiotic resistance genes in combined sewer overflows.

Nicholas Bonini  
*Professor Aaron Mazzeo*

**Characterizing Surface Behavior of Ecoflex-50**

Space travel is expensive, so it is not feasible to bring extra equipment and supplies. 3D printing offers a venue to quickly acquire tools and parts after the craft has reached space. Current technology uses thermoplastic materials, much like hot glue, to print, which may melt or otherwise fail in the harsh conditions of space; thermoset materials, formed from two or more components that cure chemically, can be more thermodynamically and mechanically stable. The development of a printer that can print thermosets could allow further versatility of 3D printers on spacecraft. In order to develop this technology, it is critical to study the surface behavior of thermosets such as silicone elastomers. The short cure time of the elastomer Ecoflex-50, though too soft for aerospace applications, suggests it may be an ideal substance for testing of curing kinetics and dispensation of thermosets. Faster cure times and reduced spreading will improve the resolution of the prints, which determines the object’s durability and quality. We used ImageJ software to map the droplets’ contact angles on Kapton film over time at different temperature conditions to determine spreading behavior. The preliminary results suggest that due to the increasing viscosity of the material over several trials, the experiment should be modified by mixing the substance as it is extruded, rather than before beginning the trial, to improve reproducibility of results. This research aims to improve understanding of the physics behind additive manufacturing in space.

Sooraz Bylipudi  
*Professor Kasia Bieszczad*

**Epigenetic Modulation Enhances Processing of Auditory Memory in a Two-Tone Discrimination Task**

Gene expression is essential for regulating neuroplasticity underlying long-term memory (LTM) formation. Epigenetic mechanisms—like histone modification—modulate gene expression by “opening” or “closing” chromatin conformation. Studies have shown that blocking histone deacetylases (HDACs) “opens” chromatin conformation, thus releasing the brakes on gene expression and facilitating LTM formation. Recent work in rats learning to associate sound with reward found that pharmacological inhibition of HDAC3 (by RGFP966) can enhance memory formation for highly-specific sound features. Moreover, RGFP966 also enabled unusually sound-specific reorganization of the primary auditory cortex (A1); a process known to strengthen newly formed memories (Bieszczad & Weinberger, 2010 PNAS). We hypothesized that blocking HDAC3 will
facilitate behavioral performance in a two-tone frequency-discrimination (2TD) task by forming strong and sound-specific memory. To test this, we trained rats (male, Sprague-Dawley, N=6) in a frequency-discrimination task. The 2TD task requires rats to learn to associate one conditioned stimulus (CS) frequency with reward (CS+) and another frequency with non-reward (CS-). Daily training will be for two weeks, either with vehicle or RGFP966. After these two weeks, refined frequency-specificity of the developed auditory memory will support increased rates of 2TD acquisition and performance in the RGFP966-treated rats. Subsequent electrophysiological recordings will reveal whether A1 is reorganized to better represent CS+ and/or CS- frequencies. These findings will further illuminate the role epigenetic mechanisms have on learning, memory, and information storage. Understanding the role HDAC3 (and RGFP966) has in memory could better therapeutic strategies to help those with disability learn highly-specific auditory information more effectively.

Anthony Carrillo  
Professor Steven Handel  
Inland Migration of Coastal Plant Species in Jamaica Bay  

With sea level rise many coastal plants are threatened to be pushed more inland. These ecosystems are ecologically important and losing these environments may be detrimental to critical animal and plant species. We are observing how plants are reacting to the sea level rise to decipher methods to keep these ecosystems intact. I am studying coastal plant biodiversity in the Jamaica Bay area in New York. We are collecting data on all native and nonnative plants species and how they will change geographically over time due to the rising tide. We are collecting the data by using transects (parallel lines) that run perpendicular to the shore. Every plant species that intersects the transect line is measured on where it lands in relation to the transect. This shows where the plants are in connection to the shore. Over time it should show how the plant species are going more and more inland, and how some species are becoming either scarcer or more common as a consequence of sea level rise. We are finding out which plants species are more resilient by using restoration plots. In these plots many different native coastal plants are planted and are put in many different places, and are subject to different treatments. These plants are planted more inland than their current natural distribution to simulate where they may be to avoid an encroaching coastline. The treatments we are putting these plants through are weeding, watering, and spraying deer repellent spray. Not every plot is treated the same, some are not weeded or sprayed with deer repellent to get reliable control and experimental groups. The results from these experiments may show us how to treat these ecosystems in the future and what may need to be done to move these ecosystems more inland for their protection.

Hill Chang  
Professor David Margolis  
Simulating Natural Whisking Through Optical Stimulation of Facial Muscles

The ability to restore naturalistic movements in regions where nerve damage has occurred can have significant benefits for therapeutic care and physical therapy, and using optogenetics to elicit movement instead of electrical stimulation allows for a non-invasive and less costly procedure. Past studies have shown that optical stimulation of certain areas of the mystacial pad in Emx-Chr2 mice produces distinct muscle contractions, and initial results from ongoing studies suggest that this occurs even in mice whose facial nerves have been lesioned. The purpose of this study was to replicate naturalistic whisker movements in anesthetized mice using optical stimulation of the mystacial pad, with the final goal being to test whether similar results can be achieved post nerve lesion. We show that precise, patterned optical stimulation can reproduce some aspects of natural whisking. While stimulation of the protraction and retraction muscles cannot induce muscle movements of the same amplitude as spontaneous whisking, it can produce movements with the same timing and velocity. Cross-correlation of the stimulated whisking with the same mouse’s
previously recorded spontaneous natural whisking shows that protraction stimulation alone does not produce as strong of a correlation as protraction and retraction stimulation, suggesting that complex movements can be more accurately simulated using more complex control systems. However, these results may not be precisely reproducible in post-lesion mice, as initial results show that there is a need to better understand changes in evoked movements after nerve damage before being able to restore natural movement via optogenetic stimulation of denervated muscle.

Wilson Chang  
Professor Sarwar Hashmi  
Effect of Dietary Salt Sodium on Fat Storage in *Caenorhabditis elegans klf-2 (ok1043)* Mutant

The 2.1 kb deletion in *klf-2* gene in *C. elegans* results in extensive fat buildup in its intestine, suggesting that *klf-2* functions to limit fat storage. Dietary salt sodium plays a major role in fat storage, but its regulatory mechanism is not yet well-defined. We study the effect of sodium salt on fat storage in a *C. elegans klf-2 (ok1043)* mutant. We also studied a plant extract which is known to have a positive effect on diabetic patients. We separately fed *C. elegans klf-2* mutant and wild type (WT) larvae on NGM agar media with 0X and 10X of sodium (3 g per liter of water) and used Oil Red O stain to measure the fat buildup in those worms. In separate experiment we also measured fat buildup in both strains of worms after feeding them on media supplemented with crude plant leaves extract. Worms fed on 10X sodium died after 4-5 days of feeding. However, the worms fed on 0X sodium exhibited lower levels of fat in the *klf-2* mutant when compared to those fed on normal sodium suggesting importance of sodium in fat storage. Since WT worms do not build up a significant amount of fat, the difference in fat between WT fed on 0X vs normal sodium was not distinct. Leaves extract showed no effect on fat build up in *klf-2* mutants. Further study will focus on the mechanism of regulation of sodium in fat storage. We identify an important regulatory function of *klf-2* in inhibiting fat storage as well as the importance of sodium in influencing fat storage.

William Cheng  
Professor Girsh Blumberg  
Studying Domain Boundaries of 1.2% Au-doped FePn (Iron Pnictide) Through Direct Imaging

We see transitions in common elements such as the phase transitions of water as it heats up to form steam or cools to form ice. These transitions in materials are important to us because we can transform elements into a more desirable state for our purposes. In my project, I am looking at the particular transitions, the TN (Néel Temperature) and TS (Structural Transition Temperature), of iron pnictides, 1.2% Au-doped BaFe2As2. Although iron pnictides are superconductors in the iron family, this particular Au-doping makes it non-superconducting. This sample has a TN = 100K and Ts = 108K. A material is paramagnetic above its TN and antiferromagnetic below it, and has a tetragonal lattice above its Ts and transforms into an orthorhombic lattice below. The structure phase transition of the iron pnictide from tetragonal to orthorhombic forms domains of opposite facing rhombus lattice cells. The linear intersection of these domains form domain boundaries, which appear horizontally and vertically relative to the pnictide’s crystallographic axis (think of an x-axis and y-axis but for a material, and each sample has a single oriented crystallographic axis). This Au-doped iron pnictide is interesting because in the parent compound, it’s TN and TS are very close to each other and sometimes indistinguishable. By having this splitting in between, we aim to figure how much of an effect both TN and TS have in creating domain walls. We plan to investigate the domain walls by direct imaging them as the sample cools from its TS to TN and comparing the photon counts of a single area as the sample cools down. Our experimental process includes cooling the sample, which is mounted in a vacuum-sealed cryostat, using liquid Helium. Our source of illumination is still being debated on as laser light and white light has both their advantages and disadvantages. Although these domain walls can be viewed by the naked eye, we use a high
magnification objective and sensitive CCD cameras to get an accurate depicture of the phenomenon between our two transition temperatures.

Shannon Cheung
Professor Michael Verzi
New Mouse Model May Indicate Different Origin of Colon Tumorigenesis

Colorectal cancer (CRC) is the second leading cause of death in the U.S. (American Cancer Society 2016). Despite its prevalence, CRC development remains a mystery. Intestinal epithelium comprises of villi, finger-like projections containing differentiated cells, and crypts, tubular invaginations housing proliferative stem cells. Stem cells found in the crypts allow the intestine to renew itself daily; however, they are also prime candidates for propagating cancerous mutations (Barker 2014). CRC’s origin is thought to lie in the crypts, where mutated stem cells migrate up towards the villi – the “bottom-up” model. By contrast, some studies have supported an alternative “top-down” model, in which CRC originates in either the late progenitors or early differentiated cells of the villi and move downwards (Puglisi et al. 2013). To investigate CRC formation, we developed mouse models in which SMAD4, a tumor suppressor, was knocked out and B-catenin, an activator of a pivotal cell proliferation pathway, was hyper-activated, creating a tumorigenic environment (van der Flier 2009). In response, ectopic crypt formation was observed in the villi. Since these abnormally positioned structures have been associated with adenoma growth, their placement on the villi may support the “top-down” model (Kim et al. 2014). Intestinal RNA samples were sequenced and analyzed to examine differentially expressed genes among the models. Results from gene enrichment analysis suggested that the cancer model relies on energy metabolism methods other than oxidative respiration. This research creates headway in understanding underlying mechanisms of CRC formation and hopefully proves useful in developing anti-cancer treatments.

Maine Christos
Professor Sunil Somalwar
The Search for the Seesaw Mechanism in 13 TeV Data at CERN

The Large Hadron Collider (LHC) particle accelerator at CERN in Switzerland collides protons at nearly the speed of light. In data from the CMS detector, there is the possibility of discovering evidence for the Seesaw Mechanism, which could explain the vanishingly small mass of neutrinos. We look for a signal of the Seesaw Mechanism specifically in decay channels which produce at least three leptons (electrons or muons). In order to be able to distinguish the signal of the Seesaw Mechanism from the background (Standard Model) processes, we attempt to define a set of signatures (“channels”) where the number of signal events compared to the background events is relatively high. We choose to look for new physics exclusively in multi-lepton events because these events are rarely produced by Standard Model processes. We then optimize the number of signal events compared to background events by selecting candidate events using variables such as the momentum of the leptons produced and the number of jets observed by the detector. After such channel selection, we use a statistical tool on the data which quantifies the hypothesis that the observations favor the presence of Seesaw Mechanism. This optimization process allows us not only to determine the conditions under which we would be most likely to observe the Seesaw Mechanism but also the allowed masses of hypothesized particles in the Mechanism given the amount of collected data. So far progress has been made on improving the ratio of Signal to background and we hope to continue until more possible masses can be excluded or a signal is found in the 2016 data.
Hannah Consiglio  
Professor JeanMarie Hartman  
Comparison of Macroinvertebrate Bioassessment Methods in Streams of Diverse Water Quality: Leaf Pack vs. Rapid Bioassessment

Freshwater macroinvertebrates range from pollution sensitive to tolerant and thus are good indicators of water quality. Bioassessment is a simple and accurate way to gauge stream or river water quality based on the ratio of macroinvertebrates found there. The leaf pack and rapid bioassessment methods for assessing water quality have differing inherent advantages and disadvantages which make either one of them the better choice for a specific study or group of river monitors. This study aims to compare the differences in data collected via these methods, in order to conclude which may be a better indication of stream conditions, rather than discuss practicality of the methods. In early summer, twenty-five sewn mesh packs were stuffed with thirty-one grams of native maple tree leaves and then distributed evenly in five first and second order streams. Rapid bioassessments of these locations were taken within a week of leaf pack distribution. Leaf packs were retrieved three weeks after distribution and rapid bioassessments were performed again at the collection sites. Leaf packs were analyzed for formation of macroinvertebrate colonies. Data from both the leaf packs and the rapid assessments were used to determine two comparable water quality scores for each site. The results of this study supply a much needed comparison between the leaf pack and rapid bioassessment methods of water quality analysis. This information is vital in finding the most effective way to carry out ongoing testing of surface water, in order to assemble short and long term plans to improve its quality.

Tyler DeFosse  
Professor Kim McKim  
Investigating the Role of the CPC in Error Correction in Drosophila Female Meiosis

The formation of sex cells, egg and sperm, occurs through a process known as meiosis in which parental DNA is effectively halved and distributed to new daughter cells. During this process the accurate segregation of chromosomes is vital for reproductive success. Failure for the chromosomes to segregate properly leads to aneuploidy, a condition known to be the leading cause of infertility in women. Since female meiosis lacks centrosomes, the ways in which spindles assemble to assist chromosome segregation still remain unknown. Previous studies have shown that a four protein complex called the chromosomal passenger complex (CPC) is important in spindle assembly. Additionally, it has also been found that mitotic CPC plays a vital role in correcting the improper kinetochore-microtubule attachments by destabilizing them. By targeting the CPC to the centromeres, we are aiming to test whether its mitotic function of correcting the kinetochore-microtubule attachments is the same in meiosis as well as also test its impact on spindle assembly. To test this hypothesis, we created two protein fusions, one consisting of the Inbox domain of Incenp (the scaffold protein of the CPC) fused with the kinetochore protein Mis12 and the other consisting of the Inbox domain of Incenp fused with the centromere protein Cenp-C. After successfully engineering the fusion constructs, they were injected into Drosophila embryos to be mapped out and studied through cytological analysis to determine if these mutants cause microtubule detachments at the centromeres.

Sarah Donofrio  
Professor Bonnie Firestein  
The Role of Cypin in Dendrite Development

Cypin (cytosolic PSD-95 interactor) is a guanine deaminase that plays a role in dendrite development. Dendrite morphology is determined by the formation of branches and spines, which facilitate communication between neurons. Many brain disorders, such as autism, schizophrenia, and Alzheimer’s disease, are characterized by altered dendrite morphology. Our laboratory reported that
increasing cypin levels increases dendrite branching in cultured hippocampal neurons, while knocking down cypin decreases branching. Cypin protein expression is restricted to the forebrain of the adult rat. As such, we asked whether cypin is expressed in different regions of the developing brain. Using immunohistochemistry and Western blot analysis, we determined that cypin is expressed in the rat cerebellum with higher levels in adult rats than in rats aged P0-P10. We also observed that cypin levels are high in regions where ZnT-3 is expressed, and previously, Dr. Firestein found ZnT-3 to interact with cypin using a yeast two hybrid screen. Because binding to zinc is essential for cypin’s guanine deaminase activity and its ability to increase branching, we are performing co-immunoprecipitation experiments to determine whether cypin interacts with ZnT-3 (zinc transporter 3) in the brain. Since ZnT-3 null mice have been found to express autistic phenotypes and to have increased BDNF (brain-derived neurotrophic factor) levels and neurite numbers, both of which are related to cypin function, we will test the hypothesis that ZnT-3 and cypin are part of a common molecular pathway that regulates dendrite morphology.

Elizabeth Dreifus
Professor Stephen Schnetzer
Searching for Vector-Like Quarks

The aim of this investigation is to determine whether Vector-Like Quarks exist. If proven to exist, these quarks, subatomic particles, would extend the Standard Model of particle physics. Previous work in high-energy physics includes the search for evidence of Super-symmetry, a concept which would solve the outstanding “naturalness” problem of why the Higgs particle is so light. However, since no such evidence has yet been found, researchers are looking at many alternatives. One such alternative is the Vector-Like Quark (VLQ). It has different properties from particles physicists have already discovered. Using Monte Carlo simulations to find what a potential signal should look like, we examine and analyze data from the Large Hadron Collider (LHC) at CERN to look for this new particle. There is no strong evidence for the existence of this particle in the data we analyzed. However, the LHC is currently generating five times as much data as we currently have. It’s quite possible that the signal is being lost in the background, and when we have more data, there will be a larger signal. Should the existence of the VLQ be proven, the implications for the field of physics would be quite large. It would indicate an exciting new realm of physics beyond the current Standard Model and stimulate research in theoretical and experimental physics.

Huafeng Fan
Professor Vladimir Pavlovic
A Mobile System for Real-time Robust Performance-driven 3D Face Tracking

Recent advances in face tracking techniques have yielded novel hybrid systems capable of automatic and simultaneous head pose and facial action tracking. These methods include fitting blendshapes to the image of a face by directly predicting shape parameters via an efficient and rapid shape regressor trained on generic RGB datasets. However, these frameworks are not viable for implementation on mobile phones, which are potentially popular platforms for such applications. We take one such existing effective framework for face tracking and remove dependencies on special hardware/software, leaving a lightweight and portable framework. As many phones and tablets do contain multi-core processors, we retain much of the performance increase due to parallel computing. The port was made to an Intel Dell Venue 8 tablet running Android 5.1.0 and retains most of the same functionality as the original system. By porting a 3D facial performance capture system to a portable platform, interesting and influential applications of such a framework can be explored in the future.
Xingye Feng  
*Professor Husam Najm*  
Experimental Testing of Pervious Concrete and the Use of Hybrid Steel Fibers in Concrete and FRP Strengthening

Porous concrete is now widely used in urban construction. Its porous feature is the main difference from the traditional concretes, and it allows water flows better from the concrete to the soil underneath and prevent the roads from flooding. However, the present pervious concretes are not stable enough and not durable when heavy loads are applied. In our research, we mix the aggregates, cements, sands, fibers and other different materials by different proportion to get concretes in various strength and permeability. To test these different concretes, we can decide the best mixture for the state road construction. Our project is still in processing and the result can hopefully be found next year. Based on our findings in the future, we can apply the most desirable mixture of concrete we find on the bike lanes of the state and create a more-friendly environment without watery ground for people to live in.

Katelyn Fleisch  
*Professor Kenneth Irvine*  
Regulation of LATS1/2 Localization by Cytoskeletal Tension and YAP Activity

The Hippo pathway is a cell signaling pathway that allows for the control of organ growth through the regulation of proliferation and apoptosis. In mammalian cells, LATS1 and LATS2 are kinases involved in the Hippo pathway that regulate the co-transcriptional activator YAP, which promotes proliferation and suppresses apoptosis. This project is investigating the effect of cytoskeletal tension and increased YAP activity on localization of LATS1/2. Tumor cells have been shown to have both increased cell stiffness and higher levels of YAP. Therefore, discovering how the Hippo pathway behaves under these circumstances could have implications for cancer research. First, to determine the effect of tension, cytoskeletal tension was increased in mammalian cells. The high-tension cells were stained in order to view the localization of LATS1. So far, it appears that increasing tension increases the amount of LATS1 in the cell. Second, we activated YAP in mammalian cells in order to detect the effects of a negative feedback loop between YAP and LATS2 on LATS2 localization. It is expected that increased levels of YAP will cause LATS2 to relocalize from adherens junctions (E-cadherin) to a more apical structure (ZO-1), which has already been shown in Drosophila. We stained the cells for LATS2, E-cadherin, and ZO-1 to determine if this re-localization occurred.

Alon Flor  
*Professor Keivan Esfarjani*  
Discrete Breather Detection Methods

Intrinsic Localized Modes, also known as discrete breathers, occur when a small set of atoms in a lattice take a lot of energy from their neighbors. They form points of unusually energetic vibrations surrounded by relative calm. Our goal was to use molecular dynamics simulations to simulate lattices under various conditions in order to detect discrete breathers. To visually detect ILMs, the energy of each atom was plotted as a function of time. This method is however only practical in one dimension. We also graphed the distribution of energies of the atoms into histograms, in order to see if irregularities within the histograms correlate to discrete breathers in the plots. If the histogram model works in 1D lattices, it could be used as a breather detector for 3D lattices, where the 1D visualizations are not feasible or readable in 3D. We also investigated other possible ways to detect breathers, such as using measures of "energy inequality" or the Gini index, borrowed from economics, to measure the concentration of energy. A reliable breather detector is needed to test any theory that predicts breather formation in materials. A successful theory of when breathers occur can have applications in designing devices that create breathers on demand. Since breathers affect the heat conductivity of a material, such a device can change its heat conductivity as needed.
Arielle Marie Gamboa  
Professor Jonathan Singer  
Photolithography System for High-Throughput Production of Ionic Liquid Thrusters

Ionic liquid thrusters are an electrospray propulsion system used in nanosatellites. The satellites are propelled forward by the conservation of momentum as high-speed ions flow from a fuel reservoir towards an electrode under a potential difference. Design of an effective fabrication method will allow for the batch production of thrusters that account for relatively little of a satellite’s mass while increasing efficiency in manufacturing and allowing for high specific impulse. Our approach employs a multistep photolithographic and self-assembly technique. In this poster, I will discuss our selection of materials and progress in completing steps of the fabrication process. Gold makes for a strong candidate for the electrode for its electrical conductivity, chemical stability, and dewetting response to laser exposure. For the photolithographic component, high aspect ratio channels can be patterned in AZ 9260 (positive tone photoresist) through UV exposure. Their flatness, however, is unsuitable in the application of thrusters, requiring further study in order to reshape them. A porous gel – that later serves to transport and direct the ionic fuel – can then deposited to fill the channels. These preliminary results present a strong potential for realizing the ultimate goal of wafer-scale parallel fabrication.

Christopher Gong  
Professor Jingjin Yu  
Seeing without Seeing: Rich Information Delivery Through Haptic Interfaces for The Visually Impaired

In America, over 20 million people live with some kind of visual impairment. With all the latest advancements in modern technology, one would think that the wooden cane would not be the most common visual aid today. However, this is not the case due to problems intrinsic to present electronic visual aids. Besides common issues like cost and longevity, most electronic aids rely too heavily on sending audio signals. Therefore, the conversion of data from sensory input to applicable information has the potential to be optimized further. This research project's main focus is to optimize the speed of data transmission through tactile senses instead of auditory senses. A novel application of haptic feedback conceived from David Eagleman's "Sensory Substitution" publication (Novich, Eagleman 2015) in which deaf people perceived specific words from certain vibration patterns. Our project innovates on this by taking aspects from virtual reality and Eagleman's concept of sensory substitution. We are designing a game in which players have to navigate through a computer maze blindfolded while receiving different vibrations based on their location in the game. Vibrations will be administered through clothing strapped with Arduino microprocessors, and signals activating the vibrations will be sent through XBee radios. The objective is to make users draw a picture of the maze in their mind with the limited information given. Insights drawn can lead to algorithms that can not only enhance current visual aids but also replace them with haptic devices, thereby enhancing the quality of life for the visually impaired.

Bennett Greenberg  
Professor Stephen Garofalini  

This project attempts to analyze the atomic structure of a bulk of aluminosilicate glass, which is used for novel optical fibers that allow for significantly reduced Brillouin gain and scattering, permitting high-energy wave transmission.1 In practice these fibers are made using a novel method called the Molten Core approach, where silica glass (SiO2) is melted and dissolved into alumina (Al2O3) to form the core of the fiber, as opposed to the traditional Chemical Vapor Deposition (CVD) method. This allows a much higher alumina concentration (CVD yields a maximum of ~12 weight%
alumina, while ~67 weight% alumina has been achieved with the Molten Core approach). In this study, Molecular Dynamics (MD) simulations were used to model the Molten Core process for an aluminosilicate glass, and the resulting glass structure was studied. A silica glass was brought in contact with an alumina crystal. The system was then heated up to elevated melt temperatures and allowed to fuse into a homogenous aluminosilicate bulk glass. This bulk was then quenched rapidly (cooled to room temperature) and the atomic structure of the resulting glass was studied. This process was repeated with different pressures, mixing temperatures, and alumina concentrations to see how these variables affect the glass structure. It was found that increasing pressure on the system, decreasing mixing temperature, and increasing alumina concentration result in denser structures with much more clustering of aluminum atoms. This helps explain the role these properties have on vibration states that inhibit use of traditional optical fibers in high-energy application.

Daniel Haddad
Professor George Carman
Phosphorylation of Diacylglycerol Kinase in Yeast

Phosphatidic acid (PA) and diacylglycerol (DAG) are key intermediates in the synthesis of lipids (fat) in the yeast Saccharomyces cerevisiae. The enzyme PA phosphatase is responsible for converting PA to DAG, and DAG can be converted back to PA by the enzyme DAG kinase. The regulations of PA phosphatase and DAG kinase activities control the relative amounts of PA and DAG. A major form of enzyme regulation is phosphorylation via a protein kinase and dephosphorylation via a protein phosphatase whereby phosphate groups are respectively added to or removed from an enzyme. Phosphorylation may stimulate or inhibit an enzyme’s activity, control its location within the cell, or control its stability/degradation. Previous work from our laboratory has shown that PA phosphatase is phosphorylated by the protein kinase known as casein kinase II (CKII). The CKII phosphorylation of PA phosphatase inhibits its function. Owing that PA phosphatase and DAG kinase catalyze complementary reactions to control the concentrations of PA and DAG, we examined the hypothesis that DAG kinase might also be regulated by phosphorylation and dephosphorylation. In this work, we used SDS-polyacrylamide gel electrophoresis to monitor the electrophoretic mobility, an indication of the phosphorylation state of DAG kinase, and Western blotting to visualize the phosphorylated and dephosphorylated forms of the enzyme. When the enzyme was treated with protein phosphatase, the electrophoretic mobility increased. These results indicated that DAG kinase is subject to dephosphorylation as well as phosphorylation and may play an important role in controlling lipid synthesis in yeast in a pathway similar to that present in human fat metabolism.

Jonathan Hanan
Professor Nancy Walworth
Msc1 Effects 5’-Fluorouracil Sensitivity of Fission Yeast Genes that Regulate Chromosome Segregation

In Schizosaccharomyces pombe, Msc1 is a component of the Swr1 complex that plays a role in histone exchange of H2A.Z. The msc1 gene is evolutionarily conserved; it is an ortholog to mammalian KDM5A and KDM5B. 5’-Fluorouracil (5FU) is a chemotherapeutic agent employed in the treatment of colorectal tumors that targets chromosome segregation and histone exchange. Defects in such mechanisms increase cytotoxicity to 5FU. Other components of the Swr1 complex display sensitivity to 5FU as single gene deletion mutants, warranting further examination of the single deletion of msc1 (msc1Δ). To test for 5FU sensitivity, growth was assessed using spotting assays involving strains of control, msc1Δ, and single gene deletion mutants known to display sensitivity to 5FU, along with msc1Δ double mutants with other genes known for 5FU sensitivity. Images were collected to visualize differences in 5FU sensitivity among the strains. Msc1Δ was revealed to show sensitivity to 5FU comparable to swr1Δ. Additionally, mutants combining msc1Δ with other gene deletions provided insight into genetic interactions that msc1 may have with other chromosome
segregation complexes: msc1Δ combined with deletions of certain genes involved in histone deacetylase activity displays an increased sensitivity to 5FU; msc1Δ combined with a deletion of heterochromatin protein Swi6 displays a recovery to 5FU sensitivity; and msc1Δ combined with deletions to subunits pht1Δ, swc2Δ, swc3Δ, swc5Δ, and vps71Δ of chromatin remodeling complex Swr1 displays a recovery to 5FU sensitivity. These interactions may provide insights into potential targets for personalized 5FU-based cancer therapy, as many of these genes have human orthologs.

Nana-Fatima Haruna
Professor Masanori Hara
Synthesis of Inorganic Polymers and their Interactions with Atmospheric Humidity

Our goal is to produce non-flammable, non-toxic and chemically resistant polymers whose structure is based on silicate. Alkali and alkaline earth metals are used to modify silica, reducing the glass transition temperature. The modified silica is mixed with ionic liquid and then compressed under elevated temperature. It is observed that the addition of ionic liquid reduces the bond strength and glass transition temperature, making it plastic-like. We have also observed that addition of water to the sample mixture further reduces the glass transition temperature. These observations bring the project closer to improving flexibility and reducing brittleness of the polymer samples. The effects of atmospheric water are also studied in order to solve the problem of the hygroscopic samples and improve the physical properties of the polymers. Usage of inorganic polymers will reduce the dependence of crude oil and promise chemically more stable materials for industrial usage. They will also be more accessible than conventional polymers because the minerals used in production (silicon and oxygen) occupy approximately 75% of the earth's crust, which is much higher than carbon (the primary element of conventional polymers) occupying 0.03%.

Rahul Ilango
Professor Mitsunori Denda
Flying Insects Flapping Robots

The analysis of insect flight mechanisms can provide valuable insights into how to best optimize their mechanical counterparts -- flapping wing robots. By studying the dragonfly, an especially adept flyer with two sets of wings, we hoped to uncover some of these insights. We used high-speed video of the insect as well as computer simulations to test and verify the efficiency of several flight parameters. Our results indicate that an insect with two sets of wings should optimize for steady flight by minimizing the aerodynamic interaction between its wing pairs. As each wing flaps, it sheds vortices which can affect flight considerably. We studied two ways to minimize these effects: by varying the distance between wing pairs and by varying the phase shift between them. Increasing distance, at first, creates significant improvements in lift with quickly diminishing returns. With regards to phase shift, dragonflies generally move their wings synchronously when they need maximum thrust (when threatened, for example) and then switch to an asynchronous motion which allows for smoother flight. Our simulations confirm this and suggest that a phase shift of 180 degrees is good balance between vertical thrust and stability.

Nikhil Jani
Professor Ashutosh Goel
Understanding the Fundamental Science Governing the Chemical Dissolution Behavior of Borate Based Bioactive Glasses

The application of glasses as ‘biomaterials’ is an area which has revolutionized the field of human biomedicine and has brought the concept of ‘surface active’ materials which have the ability to elicit a special response on their surface when in contact with biological fluids, leading to strong bonding to living bone or tissue. Bioactive glasses are an example of ‘Class A’ biomaterials. Class A bioactivity is ‘The process whereby a biological surface is colonized by osteogenic stem cells free in
the defect environment as a result of surgical intervention’. An extra- as well as intracellular response is elicited by a ‘Class A’ bioactive material at the interface. Such materials are said to be osteoprodutive. However, in order to design such a material one should understand the fundamental science governing its various physical, thermal and chemical properties. In this project we aim at understanding the fundamental science governing the chemical dissolution behavior of borate based bioactive glasses. In this pursuit, glasses in the Na₂O-CaO-B₂O₃ system, synthesized by melt-quench technique, are studied for their molecular structure by various spectroscopic techniques including infrared spectroscopy, Raman spectroscopy and nuclear magnetic resonance spectroscopy. The chemical dissolution behavior of glasses is being studied in deionized water, Tris-HCl, and citric acid buffer. The in vitro bioactivity of these glasses will be studied by studying their biodegradation in simulated body fluid. The as obtained results will be used to elucidate structure–property relationships in these glasses.

Faith Johnson  
*Professor Alyson Brooks*  
Analysis of the Formation of Milky Way-like Galaxies

There are many galaxies in the universe that resemble our own. However, we don’t know much about which feature of these Milky Way-like galaxies forms first, the central bulge or the extended spiral disk. We analyze mock images of simulated, progenitor galaxies to the Milky Way to test the evolution of the stellar mass distribution in these galaxies. These simulations are made with Sunrise, a ray-tracing software that tracks photon emission from the star particles in the simulation. To study the formation of the simulated galaxies, we look at the g-band mock images of each at redshifts z=2.5, 2, 1.5, 1, 0.6, and 0 and compare this data to real data of galaxies observed with the Hubble Space Telescope. We are testing whether the bulge and disk components of the simulated and observed galaxies grow at similar rates. If they do not, more steps will be taken to discover the cause of the divergence.

Madhura Khandekar  
*Professor Andrew Baker*  
Analyzing Molecular Gas in NGC 4138

One of the major pathways for the growth of galaxies is the merging of two smaller systems to form a larger one. NGC 4138 is a nearby spiral galaxy with some stars revolving in the opposite direction from the others. This counter-rotating stellar disk suggests that NGC 4138 is the result of a merger between two systems. We have obtained observations of carbon monoxide emission in NGC 4138 with the Plateau de Bure interferometer, one of the observatories of the Institut de Radioastronomie Millimétrique (IRAM), in order to study the galaxy’s cold molecular gas content. Using the MIRIAD imaging software package, we find that the emission is arranged in an elliptical ring with additional gas concentrated at the ring’s center. By analyzing the properties of the ring, we are able to explore the galaxy’s internal mass distribution and evolutionary state.

Christopher Kim  
*Professor Gaetano Montelione*  
The Effects of Zinc and Arsenic Trioxide on TRIM Family Proteins

Acute promyelocytic leukemia (APL) has been linked to a unique chromosomal exchange between the retinoic acid receptor α gene (RARα) and the promyelocytic leukemia gene (PML), leading to the creation of a fusion protein, PML-RARα, found in APL cells. Studies have shown that treatment of APL patients with arsenic trioxide in lieu of chemotherapy leads to a higher survival rate. This is attributed to the ability of arsenic trioxide to induce aggregation and enhance degradation of PML-RARα by SUMO-mediated pathways in APL cells (1). We conducted an experiment to replicate the results of the published study (1) using the RING domain of PML (TRIM19) as a control, while also
studying the effects of zinc and arsenic trioxide on the structure and aggregation of the RING domain of TRIM33, another TRIM protein associated with oncogenic translocations. The Zn-binding RING domains of these two TRIM proteins were expressed with uniform 15N-enrichment in E. coli cells, and purified with Ni-NTA columns. These samples were then studied by NMR spectroscopy. A 2D 15N-HSQC NMR spectrum of the RING domain of TRIM19 shows that zinc induces structure in TRIM19. Preliminary findings suggest similar results for TRIM33. We will next test if arsenic trioxide promotes aggregation of the protein. Future work will involve optimization of buffers and sample conditions to produce improved spectra, and refinement of methodologies to improve protein production yields.


Arun Kingan  
Professor Larry Zamick
Schematic Interactions of Even-Even Nuclei with many Degeneracies

In this work we studied the energy levels and corresponding isospin (T), a quantum number related to the strong force, of various even-even nuclei. We created schematic interactions by varying the input two body matrix elements. More specifically we studied the 0122, 0123, and 01234 interactions for shells f7/2, g9/2, and h11/2 respectively. By doing this we found special states that showed up multiple times in the spectra, often times in pairs. These special states seemed to be related at least somewhat to the T=2 states for each angular momentum state. We used two main programs to calculate the spectra for each shell/nucleus: Nushellx and Iris. We also used a paper by Bayman Laude which listed the T=2 states for various shells/nuclei. We combined the data from Bayman Laude’s paper and the data from the two programs and were able to determine the reason behind why these special states are showing up. The next steps are to study the transitions between shells and isospins to establish systematics and find any patterns there may be. The results of this study will help us better understand the structure of nucleus.

Victoria Klein  
Professor Mark West
Brain Activity and Affective Behavior of Rats during Cocaine Self Administration

Addiction to cocaine is a devastating pandemic that has warped modern society. Cocaine is a powerful and addictive stimulant drug, which targets the mesolimbic dopamine system. The biggest challenge in fighting drug addiction is preventing relapse to drugs. It is estimated that about 40% of treated cocaine abusers, return to regular drug use within a year from a conclusion of the therapy. (Simpson et al. 1999). NaC is a reward center of the brain and its neurons process information about reward associated cues. For this reason NaC neurons are an important target for therapies for cocaine addiction. The purpose of our research is to study the effects of an auditory tone cue, which signals cocaine availability, on the NaC neurons. We used a Self-Administration (SA) paradigm, as our animal model, throughout the experiment including during the relapse period. During the experiment, neural activity was compared during SA, withdrawal, and relapse periods. Preliminary results have shown that there are differences in neural patterns and behavior between males and females. The study’s results will be investigated further while being compared to parameters such as the stage of estrus cycle, Ultrasonic Vocalizations and Sign/Goal tracking phenotypes. Research on tone evoked neural activity is essential to understanding the neurobehavioral relationship when an individual succumbs to drug cues and relapse to abusing a substance and thus, can potentially help us understand why many individuals relapse, even after undergoing rehabilitation.
Mikio LaCapra  
*Professor Richard Riman*  
Design and Development of Luminescent Rare Earth Nanoparticles

In search of more efficient luminescent hosts yielding bright near-infrared (NIR) emission and visible upconversion, KYb2F7 was selected as a promising alternative to the well-known NaYF4 host. Rare earth (RE: Er, Tm, Ho) ion-activated particles were synthesized through a hydrothermal procedure using a water, ethanol, and oleic acid mixture. XRD and photoluminescence (PL) scans tested phase and luminescence, respectively. PL results of KYb2F7 revealed that luminescence intensity of Holmium dopants in the NIR region, and Erbium and Thulium dopants in visible upconversion are comparable to, if not greater than, those of the NaYF4 host. These results suggest that further research should be conducted to optimize both hosts for biological applications.

Tiffany Lin  
*Professor Ah-Ng Tony Kong*  
The Effects of Natural Phytochemicals Berberine and Taxifolin on Human Cancer Cells and Nrf2 Mediated Gene Expression

The most widely used treatments for cancer, like chemotherapy and radiation therapy, are highly damaging, costly, and oftentimes too late to be effective. This study considers an alternative to such reactive treatments and focuses instead on proactive prevention of cancer growth and development. We are studying two dietary phytochemicals, berberine and taxifolin, that are active ingredients ubiquitously found in traditional medicine for thousands of years. Oxidative stress is implicated as a leading cause of cancer; prevailing theory suggests that highly reactive free radicals oxidize vital components of our cells, causing stress on the cells and eventually cancer. Indigenous to human cells is the Nrf2 signaling pathway—a major mechanism in the cellular defense against oxidative stress—which renders such free radicals inert; thus, the activation of Nrf2 may help to prevent the onset of cancer. In this study, we treated HepG2C8 cells, a liver cancer cell line, using varying concentrations of berberine and taxifolin. Through the use of various histochemical assays, we determined the toxicity of these phytochemicals on HepG2C8 cells, as well as the degree of activation of the Nrf2 pathway. The MTS assay shows that both berberine and taxifolin are significantly toxic to HepG2C8 cells at certain concentrations. Preliminary results from the Luciferase assay and qPCR analysis show induction of the Nrf2 pathway. These results suggest that traditional medicine is not to be ignored, as these phytochemicals could play potential roles in cancer prevention given their anti-oxidative properties.

Samuel Liu  
*Professor Nicholas Bello*  
Altered Taste Preference in Engrailed-2 Knockout Mice

The purpose of transcription factors is to initiate transcription, where mRNA is formed from a DNA segment in the beginning of the process of making proteins. Mutations of the Engrailed-2 (En-2) transcription factor are believed to be involved in neurodevelopment processes involved in autism-related behaviors and sensory processing. Taste is one sensory modality which has been implicated, but understudied, in autism spectrum disorder (ASD). Using mice, we plan on studying the effects of En-2 on taste sensitivity. We expect that the taste sensitivity of En-2 knockout mice (KO) should be different from that of wild type mice. Using a two-bottle preference test with differing concentrations of saccharin, quinine, HCl, NaCl, and monosodium glutamate (MSG) paired with water, we measured how much of each solution was consumed. Intake was measured at 24 and 48 hours. The two bottles were switched after the first 24 hour period to prevent place association. We found that the only difference was that the KO mice preferred NaCl solution at the 75 and 150 mM concentrations more than the wild type mice did when compared with water. No other solutions showed any significant differences between KO and wild type mice (P<.05). This raises the question of why En-2
affects taste sensitivity of NaCl, as well as what implications that may have with individuals with variants of the Engrailed-2 gene.

**Angela Maeng**  
*Professor Patricia Buckendahl*  
The Role of Osteocalcin in Spinal Neural Function and Bone Mineralization after Hindlimb Disuse of Wild type and Knockout Mice  

The protein osteocalcin (OC) mainly functions to control bone mineralization. OC knockout mice recovered motor function faster than wild type (WT) mice while also losing less cortical bone, determining that osteocalcin has a role in affecting WT and OC knockout bone and recovery differently. However, the OC gene is also expressed in the sensory neural ganglia and spinal cord. Therefore, the lack of osteocalcin may have a role in spinal cord injury recovery by restoring the function of hind limbs after extended periods of disuse. OC knockout mice recovered motor function faster than WT mice while also losing less cortical bone, determining that osteocalcin has a role in affecting WT and OC knockout bone and recovery differently. We are comparing the tissues of both types of mice using the hindlimb unloading model to simulate extended disuse in the presence of intact neural function. RNA extraction and PCR analysis will allow us to determine the genotypes and expression of various genes of the mice. We will also compare the bone density and strength of WT and OC null mice. Bone morphology determined by MicroCT analysis will show us the role osteocalcin has in affecting KO and WT mice bone metabolism respectively. Data will indicate how lack of osteocalcin in KO mice affects disuse, neural function, bone density, and expression of various proteins in KO mice compared with WT mice. It will confirm that osteocalcin has an extended role in areas other than in bone, including the spinal cord and energy metabolism.

**Anisha Mahat**  
*Professors Sanjeeva Murthy and Joachim Kohn*  
The Fabrication and Characterization of Hybrid Scaffolds with Airbrushed Fibers  

Scaffolds serve as a framework for engineering biological tissues. Well-designed scaffolds promote and enhance the regenerative capabilities of tissues for a faster and more effective recovery. The key features required are macro-structures for strength, and nanostructures for mimicking the natural extracellular matrix. These can be achieved in hybrid scaffolds by combining 3D printed struts for macro-structures with airbrushed fibers for nanostructures. In this project we focused on optimizing the fabrication of airbrushed tyrosine-derived polycarbonate fibers and characterizing hybrid scaffolds for biological responses. After testing several variables during airbrushing, certain optimal ranges were discovered for improved fiber formations. The distance from the airbrush to the target and the concentration of the polymer solution were found to determine the number of defects (beads, films and/or fiber bundles) formed on the scaffolds. Defects were quantified to determine the optimal distance at 20 – 25 cm and the optimal concentration (w/v) at 6 %. To test cell response to different densities, human dermal fibroblasts (hDFs) were seeded onto hybrid scaffolds with different airbrushed fiber densities. At high density, the hDFs were more concentrated on the airbrushed fibers than on the 3D struts, while at low density fewer cells were recorded and more cells were attached on the 3D struts. In addition, amorphous calcium phosphate was added to the polymer solution for airbrushing to study calcium ion release and human mesenchymal stem cells differentiation. The optimization and characterization of hybrid scaffolds in this project provides a foundation for future biologically functional medical devices.
Collin McManus  
*Professor Barth Grant*  
SNX-1 and RME-8 interaction in C. elegans via the Yeast Two Hybrid System

In C. elegans, RME-8 (receptor mediated endocytosis-8) is a DNAJ domain protein in the retrograde recycling pathway in which endocytic cargo is moved to the Golgi for recycling to the plasma membrane. DNAJ domains bind and stimulate the ubiquitous chaperone Hsc-70. RME-8 binds to SNX-1 (sorting nexin-1) and its own DNAJ domain, but binds better to SNX-1 without a DNAJ domain. This suggests RME-8 is normally in an auto-inhibiting conformation which is relieved by the SNX-1/RME-8 interaction. In a yeast two hybrid screen for mutants that affect SNX-1/RME-8 interaction, a change in residue 1955 from glutamic acid to lysine was found to improve interaction. We hypothesized that this mutation either affects SNX-1 binding directly, a gain of function mutation, or inhibits the competing RME-8 self-binding interaction, a loss of function mutation. We discerned this in two ways, through a mutation to alanine and by testing for self-binding directly. If the glutamic acid to lysine mutation is a gain of function mutation, we expect an alanine substitution, considered a loss of function substitution, to have the opposite phenotype. If the lysine mutation is a loss of function mutation, we expect the alanine substitution to have the same phenotype. To test for mutant RME-8 self-binding directly, we’re performing a more sensitive yeast two hybrid assay. The retrograde pathway and the proteins involved are homologous in various organisms including C. elegans, drosophila, and humans. Future research may involve investigating these mutations in vivo and examining their effects on endosomal sorting.

Karl Mulligan  
*Professor Karin Stromswold*  
Determining Effects of Verb Stem Lengthening by Sentence Construction

Previous research by Stromswold et al. (2003, under review) and Rehrig et al. (2015) demonstrates that verb stems (e.g. hug-) are longer in passive sentences (the girl was hugged...) than progressive active sentences (the girl was hugging...). This study investigates the cause and locus of this effect. This difference could be due to monosyllabic lengthening because the progressive suffix –ing adds a syllable to the stem, but not the passive suffix –ed. It could also be caused by phrase-final lengthening, because verbs are syntactically phrase-final in passives, but not actives, and syntactic boundaries often align with intonation boundaries (Kreiman 1982; Lehiste & Wang 1977). Eight monolingual English speakers produced passives (the girl was hugged around the waist), progressive actives (the girl was hugging a dog), past actives (the girls hugged a friend), and perfective actives (the girl has hugged a toy). If monosyllabic lengthening alone affects stem duration, progressive active stems should be shorter than other types. If phrase-final lengthening also affects verb stem duration, passive stems should be longer than all other types, and perfective and past active stems should be longer than progressive active stems. Although there were differences among participants, preliminary analyses indicate that passive verb stems are longer than past and perfective active stems, which in turn are longer than progressive active stems, suggesting that monosyllabic lengthening and phrase-final lengthening both significantly cause passive verb stem lengthening. This research spans both phonetic and syntactic linguistic domains, and may help us better understand how we process sentences.

Daryll Munoz  
*Professor Fuat Celik*  
Photocatalytic Biomass Reforming Using TiO2

Finding renewable and sustainable energy continues to become a focus for many researchers. Hydrogen, a clean burning fuel, is a viable alternative energy source. Our research focuses on the photocatalytic steam reforming of methanol, a simplified model for biomass, over modified Titanium Dioxide (TiO2) nanoparticles to produce hydrogen gas. Anatase TiO2 is a photocatalyst with high
activity and stability under reaction conditions, but has a high band gap energy of 3.2 eV and only absorbs energy in the UV range, which makes up only 4% of sunlight. To extend the activity of TiO2, we study methods to shrink the band gap energy so that the photocatalyst is able to absorb part or all of the energy from visible light, 43% of sunlight. We focus on various methods of lowering band gap energy, decreasing particle size, and increasing activity. The three methods that we use to modify the TiO2 are incipient wetness impregnation to support metal nanoparticles on the TiO2 surface, High Temperature High Pressure Annealing to create Ti3+ centers, and Low Pressure Flame Synthesis to make carbon doped TiO2 with small particle sizes. Once TiO2 particles are synthesized I analyze them via UV-Vis spectroscopy, diffuse reflectance, and derivative peak fitting to determine the Kubelka-Munk Units (KMU), which are analogous to absorbance, and band gap. Once the absorbance and band gap energy is known we are able to hypothesize which samples will make good UV-photocatalysts and which will make good Visible-light-photocatalysts.

Michael Nitzsche
Professor Mona Zebarjadi
Developing Procedures for Synthesizing and Testing Organic Thermoelectrics

Thermoelectric materials serve important roles in power generation and heating and cooling. Many of the currently used inorganic materials are either too expensive, brittle, or toxic for commercial viability. Organic semiconductors potentially offer an inexpensive, nontoxic alternative, but further research and development are needed. By using PEDOT:PSS, a thermoelectric polymer with known properties, as a reference point, it should be possible to calibrate a procedure for fabricating and testing thin film samples of other unknown organic semiconductors. To achieve this end, PEDOT:PSS samples were fabricated with various methods and then tested for resistivity and Seebeck Coefficient to determine their viability. Resistivity was determined using a Van der Pauw technique, and inplane Seebeck coefficients were determined by applying a temperature gradient using a heater and measuring the resulting temperature and voltage drop over the sample. We used data gathered by thermocouples in conjunction with a nanovoltmeter to probe temperature and voltage. By sonicating pieces of glass in a series of solvents (methanol, isopropanol, toluene, and acetone) and then subjecting them to an oxygen plasma treatment, they were shown to be ideal as a substrate for drop casting thin film samples of PEDOT: PSS with the desired characteristics. These procedures for fabrication and testing of samples provide a basis to make high quality organic thin films and to learn more about the thermoelectric properties of organic semiconductors in future experiments.

Jill Park
Professor Maria Makarova
Changes in Shelf Bottom Water Conditions on the New Jersey Paleoshelf during the Paleocene-Eocene Thermal Maximum

The Paleocene-Eocene thermal maximum (PETM) was an abrupt warming event initiated 56 million years ago and characterized by a 5-8°C global temperature increase. The goal of my study is to reconstruct bottom water conditions on the New Jersey paleoshelf during the PETM using stable isotopes of benthic foraminifera in the Millville core that recovered an expanded (16 m) PETM section. Benthic foraminifera are unicellular organisms that live on the seafloor or within the shallow sediments. They use calcium [Ca2+] and carbonate [CO32-] ions from seawater to calcify their shells and thus record water chemistry. I collected species from three genera (Cibicidoides, Anomalinoides, and Gavelinella) and analyzed them for carbon (δ13C) and oxygen (δ18O) isotopes using mass spectrometry. The δ13C records show a sharp decrease of ~3.5‰ across the PETM onset, marking the globally recognized carbon isotope excursion (CIE). Coupled benthic and planktonic (surface dwellers) carbon isotopic records indicate a 3‰ vertical gradient in the water column on the shelf. This is much higher than δ13C vertical gradients in the modern ocean (<2‰) and has been explained as evidence for more efficient cycling of organic carbon during the PETM. δ18O records of benthic foraminifera show a 2‰ decrease across the CIE onset, suggesting seafloor warming of ~7-10°C
Cystinuria is a genetic disorder characterized by defective reabsorption of the amino acid cystine out of the kidneys and into the blood, resulting in a buildup of cystine and formation of painful chronic stones in those affected. Current cystinuria treatments include consumption of large volumes of water to reduce cystine concentrations in the bladder and kidneys and specific drug therapies that react with cystine to prevent stone formation. Implementation of treatments has been ineffective and unfeasible due to difficulty in patient compliance or adverse drug reactions that could be life-threatening. Consequently, there is a need for a new treatment strategy that is reasonable with respect to patient compliance and has minimal side effects. Using a mouse SLC3A1 knockout model for cystinuria, we propose the implementation of “molecular imposter” compounds that interact with preliminary crystal formation and thus disrupt formation of stones. The primary compound is an L-cystine diamide, called LH708, and is used as the basis for what we hope will develop into a better treatment strategy for cystinuria with regard to pharmacokinetics and overall bodily toxicity. Methods include genotype analysis to ensure each mouse group has or lacks the gene of interest and other genetic assays. We performed oral drug administration and, after a certain age, we took Computer Tomography (CT) scans of mice in each group to analyze stone formation rate in the bladder. By evaluating the compounds’ effects on stone formation, overall pre-clinical drug efficiency can further the process of drug discovery for human cystinuria patients.

Kishan Patel
Professor Pal Maliga
Bacillus Subtilis Promoters for Regulated Gene Expression in Chloroplasts

Plastid-encoded plastid RNA polymerase (PEP) core consists of five subunits (α2, β, β’, and β’’) that reversibly associate with sigma factors. The sigma factors are encoded for in the nuclear genome, translated in the cytoplasm, and imported into the chloroplast to assemble with the PEP core to initiate transcription from plastid promoters. The transcription machinery between chloroplasts and bacteria is highly conserved. By exploiting this conservation, we designed a synthetic transcription system consisting of Bacillus subtilis promoters and the corresponding Bacillus subtilis sigma factors that will assemble with the PEP core. We have found that the PEP does not recognize GFP reporter genes expressed from B. subtilis promoters. We are now expressing engineered B. subtilis sigma factors for expression in the chloroplasts. We expect that if the B. subtilis sigma factors assemble with the PEP core, the GFP reporter genes will be transcribed, and the protein will accumulate. The next step is testing sigma factor activity by GFP accumulation in the chloroplast. The new system will be used to arrest protein production to desired tissue types by expressing the sigma factor gene with a tissue specific promoter.

Riva Patel
Professor Cynthia Koziol-White
Inflammatory and Contractile Pathways Regulated Following Rhinovirus Exposure

Rhinovirus (RV) is the most prominent respiratory virus that is responsible for a majority of common colds. RV infections are known to cause airway hyper responsiveness and are suspected to induce asthma in atopic, or genetically predisposed individuals. Studies have shown RV infection elicits an inflammatory response, however, researchers have only briefly explored the pathways and mechanisms involved in this virus response. In this study, we analyze the signals associated with
processes of inflammation precipitated by RV. We hypothesized that RV16 potentiates airway contractility through modulation of Ca2+ dependent and independent mechanisms. To do so, human airway smooth muscle (HASM) and epithelium cells derived from healthy human donors were co-cultured. We measured Ca2+ flux by bulk Ca2+ imaging, and phosphorylation of MYPT1 and MLC by western blot assay. Precision cut lung slices from human lungs (HPCLS) were exposed to RV16 (48 hrs at 33°C) and airway contractility was measured following carbachol, a contractile agonist, stimulation. The data showed, PCLS exposure to RV did not enhance contractility to carbachol, but it induced the release of IL-6, IP-10, MIP1beta. Overall, we expect augmentation of contractile pathways and increased gene expression, resulting in an enhanced inflammatory and contractile responses, in the presence of RV.

Daniel Rodriguez  
Professor Xiang Liu  
Statistical Comparison of Train Accident Rate: Methodology and Decision Support Tool

Freight railroads transport 43 percent of the intercity ton-miles of cargo in the United States. Accidents can disrupt this and potentially cause significant consequences with respect to human health, property, and the environment. Therefore, it is important to evaluate and manage railroad operational safety based on safety metrics. One of the most commonly used metrics is train accident rate, which is defined as the number of accidents normalized by traffic exposure. Although empirical (observed) comparisons using this rate have been extensively studied for comparing railroad safety performance, it does not account for random fluctuations in accident occurrences. When these empirical rates differ, it is not well understood what proportion of this difference is caused by stochastic variation and what proportion of this change is reflective of the actual safety change. This paper aims to close this knowledge gap theoretically and practically. First, we provide a generalized statistical methodology for statistically comparing train accident rates. Based on empirical accident rates, this methodology can determine whether one rate is statistically higher than the other, across different railroads or time periods. The methodology is implemented into a computer-aided decision support tool that allows analysts to perform the statistical comparison of train accident rates. The methodology and decision support tool developed in this research can assist the railroad industry in monitoring, evaluating, and comparing these rates. In the future, this research can also support the industry’s ongoing initiative in developing a data-driven safety management system based on a quantitative understanding of past accident data.

Caillin Ryan  
Professor Lisa Klein  
Synthesis and Characterization of New Paraffin Hybrid Melting Gels

Glasses have always been coveted as some of the best insulators in the world for both thermal and electrical applications. However, their main drawback is that they require extremely high temperatures to melt. This high energy consumption leaves a large carbon footprint, makes fabrication expensive, and limits substrates to only high temperature materials. Meanwhile, plastics melt at a fraction of the temperature of their glass counterparts, but are comparatively poor insulators. Fortunately, melting gels take the best of both worlds by combining the insulating strength of a glass with the low melting point of a plastic. Melting gels are hybrids of glass and polymer that are solid at room temperature but are liquid-like at around 110 °C. However, after 160°C, the gels will permanently consolidate into glasses that can no longer melt. Most notably, when paraffin wax is mixed with these gels, the resulting material demonstrates radically new mechanical and insulating properties. For instance, malleability and shape retention are increased while density and adhesion decreased. By subjecting several gel compositions to a variety of tests, preliminary trends and characterizations were observed. These quantitative results were obtained for hardness, elasticity, density, and electrical insulating strength. Based on these results, the special properties of this material can be tailored for new and exciting applications. For example, these
hybrids can be molded, imprinted, or even 3D printed into inexpensive, glass objects. Moreover, they can easily cover most materials providing fire retardancy, chemical resistance, electrically insulation, and water repellency.

Belal Said  
*Professor Mubbasir Kapadia*  
Computer Simulations Applied To Crowd Movements for Evacuations

Building efficient evacuation plans for buildings is quite difficult with no quantifiable basis. Since building safety can only be tested after they're built, it turns out the best way to estimate the safety of a building is using a computer simulation. Using C# and C++, we built a modification of SteerSuite, a crowd simulation software, and integrated the simulation software into Autodesk Revit, a 3D modelling software for Building Information Modeling. With the simulation software, users can utilize a quantifiable benchmark such as time to evaluate the safety of different building designs. The benchmark is extracted and presented to the user in a meaningful way. With some challenges, the software was integrated seamlessly into Revit as a user friendly plugin that requires no knowledge in computer science to operate.

Ayman Saleh  
*Professor Georgios Tsilomelekis*  
Structure-Function Relationships in Biomass Reactions

The capability to use biomass as a source for the large-scale production of liquid fuels and chemicals relies on the development of effective low temperature energy processes. In particular, 5-hydroxymethylfurfural (HMF), a biomass derivative which has been noted by the United States Department of Energy as one of the top 12 platform chemicals for the future, shows potential as a new source of energy. Production of 5-HMF stems from two chemical process: glucose isomerization and fructose dehydration. The challenge of these processes is finding a catalytic system that can effectively perform both isomerization as well as dehydration reactions in one single reactor system. Lewis acid catalysts such as Chromium (III) Chloride, Tin (IV) Chloride, and Aluminum Chloride have been found to perform as lewis acid/bronsted base bifunctional sites. Although these catalysts exhibit exceptional performance in 5-HMF yield under certain conditions up to 70%, 26%, and 35% respectively, disassociation of these homogeneous catalytic systems in water and other solvents into complex ions limits our understanding. I have sought to elucidate this important information about the catalyst/solvent system. Characterizing the individual complexes to Raman and FTIR active bands is a key step in order to determine vital information on the speciation of these catalysts such as concluding the active species in the catalytic system. Through my work, I have found that in SnCl4 & CrCl3 solutions, the [SnCl4 (H2O) 2] and the [Cr (H2O) 5OH] 2+ complexes are indicated as the active species according to experimental data.

Mohammed Salem  
*Professor Mehd Javanmard*  
The Effect of Voltage and pH on Antibody-Antigen Interactions

Many techniques that measure physiological parameters usually require the utilization of data accumulated over a rather minute time frame. Continuous measurements, however, would be much more reliable for diagnosing disease and would provide better understanding of patients' health. Our team is working on a small wearable device that can constantly detect levels of specific proteins using antibodies. The problem is that there are too many proteins to measure with a single device before compromising the portability, which is why it would be critical to be able to reuse the antibodies for detection. Our aim is to figure out a way to separate antibodies from antigens by applying voltage through the use of an electrode functionalized with reduced graphene oxide. Previous efforts have been made by using Indium Tin Oxide, but graphene is a much better choice.
Graphene is one of the most intriguing choices because of its tremendous characteristics including its incredible strength, lightweight, and most importantly, superconductivity. We will be reducing graphene oxide on a gold electrode and then functionalizing the surface with mouse antibodies. Next, we will immobilize fluorescent antigens on top of the antibodies. By applying a constant voltage through a potentiostat, and using a fluorescent microscope to monitor the interaction between the antibodies and the fluorescent tagged antigens, we will try to find the optimal voltage and pH that would separate the antigens and antibodies from each other. This information can be applied in nano-devices to continuously monitor proteins around the body.

**Daniel Schaare**
*Professor Spencer Knapp*
Determining Structure of Antimalarials

In pharmaceuticals, many compounds come in two different forms called enantiomers, which, like one’s right and left hands, are mirror images of each other. In theory, these enantiomers are functionally identical; however, biological systems tend to favor one enantiomeric form over another due to the innate stereochemical properties of enzymes and proteins. Consequently, only one enantiomer of a drug is active because the other form does not have the correct structural properties to bind at the target site. When studying the antimalarial compound (+)-Sj-733, the Knapp group found certain analogs of the compound where both enantiomers are active or where the enantiomeric preference had switched completely. One explanation of this phenomenon is that the drug binds to the target site in a flat confirmation, which reduces enantiomeric selectivity. In order to verify this hypothesis, I have synthesized analog compounds that favor a flat conformation. The “flatness” of the analogs are measured from the coupling constants in NMR spectra, which determines the H-C-C-H bond angle. So far, the two compounds that I have synthesized have coupling constants around 4-5Hz, which indicates a 50:50 mixture of flat and protruding conformations. Such a potential finding could play a factor in the process of determining the switch in drug enantioselectivity.

**Patricia Shelton**
*Professor Alexander Niemark*
Monte Carlo Simulations of Carbon Dioxide Adsorption in Hierarchical Nanoporous Carbons

In recent years, a novel class of nanoporous materials have been synthesized which are known as hierarchical carbons. Hierarchical carbons are prized for their large surface area due to extensive micro- and mesoporosity (pores between 0.3-50nm). The relative ease with which they are synthesized and the ready availability of carbon sources have led to their proposed application in water treatment and carbon dioxide sequestration. In this research project, we model carbon dioxide adsorption in carbon nanopores with Monte Carlo simulations using the Grand Canonical Method. The results from these simulations are adsorption isotherms, which show the density of carbon dioxide molecules adsorbed within the carbon pores as a function of the imposed pressure and temperature. We hope to use these simulated adsorption isotherms to better understand the behavior of carbon dioxide in hierarchical carbons over a wide range of pressures by constructing an “adsorption isotherm kernel.” This is used to determine the surface area, pore volume, and mean pore diameter of real life hierarchical carbons based on the analysis of corresponding experimental carbon dioxide isotherms. This research will help us better understand the structural properties of hierarchical nanoporous carbons for various applications including gas storage and mixture separations.
Organocatalysis refers to the use of organic molecules as catalysts, which serves as a cheap alternative to many expensive and hazardous organometallic catalysts. A thiourea organocatalyst is a class of organic catalysts that contain an electron deficient thiourea group which acts as a hydrogen bond donor and activates an electrophile. Likewise, a bifunctional thiourea organocatalyst contains both a hydrogen bonding site and a base component within the same molecule. This type of organocatalyst is utilized in order to increase reaction rates while maintaining stereoselectivity of the desired product. Currently most bifunctional thiourea organocatalysts utilize an amino group as the base and a thiourea as the hydrogen bond donor. An issue with the amino group arises in base-sensitive reactions such as the oxa-Pictet-Spengler reaction where the amino group is to basic. Our group has alleviated this issue by using a second thiourea group to act as a base by taking advantage of an electron-rich environment in order to make it less basic compared to the traditional amino group. With this new approach of thiourea organocatalysis we have developed the first highly stereoselective oxa-Pictet-Spengler reaction. However, the production of the bifunctional thiourea organocatalyst needs to be optimized to become more applicable in other reactions. With an optimized synthetic route our group can develop an efficient and robust catalyst that can both maintain stereoselectivity in base-sensitive reactions, and act as a cheap alternative to other difficult to manufacture organocatalysts.

Fady Soliman  
Professor Joseph Jude  
Effects of the Industrial Toxicant dinitrochlorobenzene (DNCB) on Human Airway Smooth Muscle

Asthma is an airway inflammatory disorder characterized by enhanced narrowing of airways (airway hyperresponsiveness-AHR). The smooth muscle layer in the airway plays a pivotal role in AHR. Dinitrochlorobenzene (DNCB), a chemical and contact sensitizer, is found in industrial settings and poses occupational hazard to workers. The effects of the chemical DNCB on airway smooth muscle (ASM) are not known. We hypothesize that DNCB acts on ASM cells to enhance contractile function and elicit airway hyperresponsiveness. To test our hypothesis, ASM cells from human airways were cultured and exposed to DNCB (0.01 uM - 1 uM) for 24 h. Two markers of enhanced contractile function in ASM cells, namely pMYPT1 and pMLC, were determined by western blot. Further, oxidative injury was assessed by expression levels of two genes: NADPH-quinone oxidoreductase 1, NQO1 and thioredoxin -Trx1. Mobilization of intra-cellular Calcium ions, which is critical for ASM contractile function, was also determined after DNCB treatment. DNCB enhances pMLC level, one of the markers associated with contractile response in ASM, with little effect on pMYPT1 level and intra-cellular Calcium ion mobilization. Further, DNCB causes oxidative injury in ASM cells, characterized by increased NQO1 levels. The findings indicate that DNCB acts on ASM to enhance AHR. However, the classical signaling pathways involved in the development of AHR (i.e.: Calcium ion mobilization) do not appear to mediate the DNCB effects on ASM. These findings will shed light on potential therapeutic targets in ASM, that could be exploited in asthma induced by DNCB and related industrial toxicants.

Alexandra Spitzer  
Professor Jennifer Lynch  
Graphene Reinforced Polyisoprene Surgical Gloves

Polyisoprene is a common and easily produced form of synthetic rubber. Due to the high allergy risk that could be potentially harmful to both patients and doctors, polyisoprene is replacing natural rubber for many uses including surgical gloves. However, the puncture resistance of polyisoprene is between 61mN and 103 mN, allowing needles to puncture the gloves with minimal force creating a
huge threat to the sterility required. By reinforcing the polyisoprene with graphene, a single layer of graphite that is incredibly stiff, sturdy and small, the new compound created should increase in puncture resistance. The polyisoprene and graphene compounds were created using a high shear processing mixer, creating evenly dispersed compounds of varying ratios of graphene to polyisoprene and are mixed for various times. As polyisoprene is a thermoset, meaning the polymer must undergo a heated curing process, the polymers processed were cured and films were created using a coagulant dipping process. Finally, these films were tested for their puncture resistance using a needle and load cell setup. After data analysis, the graphene reinforced polyisoprene were found to offer puncture resistances between 95 mN and 194 mN depending on the ratios and of graphene used and time spent on processing. Ultimately, the impact of these studies are very beneficial to the medical community, as the issue of sterility will always be paramount. Through experimentation there is conclusive data that more puncture resistant films can be produced with graphene reinforced polyisoprene, paving the way for more puncture resistant gloves to be produced in the future.

SaraAnn Stanway
Professor Chirag Shah
Elevating the Quality of Social Media-Sourced Data Analytics with SOCRATES

With a multitude of available social media platforms to utilize, users regularly generate vast amounts of potentially useful data. Unfortunately, harnessing and making use of this information can be tedious and complicated. InfoSeeking’s SOcial and CRowsourced AcTivities Extraction System (SOCRATES) makes the collection and analysis of data more easily accessible, offering multi-faceted data seeking techniques to elevate the quality of information analysis for research teams. At the outset, SOCRATES offered simple options such as adding/subtracting fields and detecting correlations between variables, but as the needs of users span more variables, they may require specialized formulas and operations. To supplement the existing basic analytic operations, I added open ended math functionality to the platform, in which a user has the ability to enter their own formula and field to examine. To further optimize the depth and potential impact of data analysis, the SOCRATES project, originally supporting single-user sessions only, requires the capability to grant access of a single project to multiple users, rendering methods of information collection more easily accessible to the public. In the first stage of this goal, I implemented a function which records user activity in sets of workflows at runtime, creating a blueprint by which data collections and analytic results may be replicated: the social media platform, search query, and analytic tools involved are all saved by work session. In future development, teams will have the option to collaborate on joint projects in real time, with the eventual goal of an integrated system in which users, based upon their research queries, will be notified by the SOCRATES system of existing projects investigating similar material, elevating the quality and speed of research through potential partnerships and the sharing of analytic strategies.

Alina Thokkadam
Professor Shishir Chundawat
Thin Layer Chromatography Method Development for Qualitative/Quantitative Analysis of Oligosaccharides

Glycosynthases are enzymes that have been mutated so that they synthesize carbohydrates. A method of identification of these carbohydrates needs to be developed so that the products of the glycosynthase reaction are known. Thin layer chromatography (TLC) is a preferred method of separating and detecting mixtures of oligosaccharides because it is quick and inexpensive in comparison to other methods. Silica was used in this study as the stationary phase while various mobile phases were used to optimize the separation of mono- and oligo-saccharides. Different compositions of solvents such as methanol, propanol, butanol, ethyl acetate, acetonitrile and acetic acid were used to test the separation efficiency of two model carbohydrates (i.e. glucose and
cellobiose). Sugars on the TLC plate were visualized by spraying a solution of 0.1% orcinol and 10% sulfuric acid in ethanol to the developed plates. The plates were heated to 135°C for 2 minutes, causing a purple/orange color to develop. The optimal mobile phase was found to be isopropanol-ethyl acetate-water (10:5:1) based on the resolution obtained from orcinol staining. The detection limit of these two carbohydrates occurred at 2 mg/mL. The mean retention factor (Rf) value of glucose and cellobiose were found to be 0.64 and 0.53 respectively. Multiple runs under the same conditions yielded similar Rf values, indicating that the method is reproducible. Glycosynthase enzymes can now be used to synthesize oligosaccharides and characterized using the TLC method developed in this study. Furthermore, TLC can be used in the biofuels and biopharmaceuticals industry to identify important carbohydrates.

Deepti Upmaka  
*Professor Vladimir Pavlovic*  
Food Recognition with Weakly Labeled Images using Convolutional Neural Networks

In order to combat the widespread obesity we will be creating a wearable device that can monitor the user’s eating habits through automatic food detection. The final product includes the image detection and analysis of the food consumed. In this research, our proposed method uses convolutional neural networks (CNN) for automatic food segmentation which plays a critical role in estimating user’s food consumption. The key challenge in building the CNN-based segmentation is that it requires pixel-level annotated images during training. However, this is time-consuming and requires human effort. On the other hand, weak labels in the form of image-level labels are much easier to construct than the pixel-level annotations. First, we train a CNN to estimate an image-level label for an input image. The food location in the image is computed using backpropagation of the trained CNN. Using an image segmentation technique, GrabCut, we further refined the saliency map (image boundary) to generate pixel-wise labeling. Then we proposed to train the fully convolutional networks (FCN) with the pixel-level annotated images. Finally, we refined the prediction of the FCN by structure learning methods, e.g., conditional random field (CRF) which takes into consideration the annotation of the neighboring pixels. By combining the deep learning method and the structure learning, our method will result in greater performance than independently using FCN. Through our methods, we hope to garner a greater accuracy with which food is recognized. These findings suggest that we have an efficient method of food recognition and segmentation to implement in the wearable device to create a personalized assistant.

Krishna Varre  
*Professor Richard Padgett*  
Usage of Co-CRISPR to Increase Rate of CRISPR Events in D. melanogaster

As versatile as the CRISPR-Cas9 genome editing system is, there are shortcomings, the most important ones being the low efficiency of the editing event (2-20%) combined with the possibility of no visible phenotype for the mutation of the gene of interest. Here we show for the first time that a CO-CRISPR system is highly efficient in identifying mutational events at a secondary locus in Drosophila melanogaster allowing for the rapid creation and identification of editing events using the CRISPR-Cas9 system. The idea is to mutate a locus that has an easily identifiable phenotype and assay animals carrying the first event for the second event in your gene-of-interest. We used the easily identifiable ebony gene as our CO-CRISPR, which when mutated leads to a change in body color from pale white to a darker brown. Our lab studies the Transforming Growth Factor-b (TGF-b) signaling pathway and we opted to generate mutations in lambik, a gene known to regulate the pathway in other model organisms. Guide RNAs against ebony and lambik were injected in Cas9 expressing fly embryos. F2 ebony flies were obtained at a high frequency showing the activity of the CRISPR-Cas9 system. We then screened ebony flies (via PCR) for the presence of mutations in the lbk gene. We show that lbk mutants are observed at a very high frequency (65-80%) in flies that also
contain mutations in the ebony gene highlighting the use of the CO-CRISPR system to quickly identify rare mutational events.

Asrita Vattikonda  
*Professor Gary Aston-Jones*  
Role of Anterior Cingulate Cortex and Dorsal Striatum in Economic Demand for Cocaine in Rats

Lesions of the anterior cingulate cortex (ACC) have been shown to reduce the amount of effort an animal is willing to expend to obtain a reward, including food and cocaine. One of the primary projections of the ACC is to the dorsal striatum (DS), which is also known to play a role in reward and decision-making. In this study, we asked whether activity in the ACC and DS is correlated with an animal’s motivation for cocaine reward. Sprague Dawley rats (n=17) were trained on a cocaine self-administration behavioral economics paradigm, which assesses an animals’ motivation for cocaine. Animals were transcardially perfused with 4% paraformaldehyde 90 minutes after their Pmax, the point at which they ‘paid’ their highest price for cocaine. We used immunohistochemistry to stain the brain tissue for Fos protein expression, and quantified Fos-positive neurons in ACC and DS to estimate neural activity in these brain regions during the task. A group of rats (n=10) were perfused 90 min after being assessed for locomotor activity, to control for the effects of motor activity on Fos expression. We anticipate that Fos expression in the DS will correlate with Pmax, indicating that activity in the DS increases when there is a higher price for the reward. If activity in both the anterior cingulate cortex and the dorsal striatum is correlated with Pmax, this could imply a correlation between neural activity in these two parts of the brain. Inhibiting this ACC-DS projection may be a potential target for therapeutics designed to treat individuals with drug addiction disorders. Our lab is currently using DREADDs (designer receptors exclusively activated by designer drugs) to further explore this concept.

Charlotte Zuber  
*Professor Sean Oh*  
Detection of Spin Polarization in Ferromagnet-Topological Insulator Devices

Topological insulators are a special class of material defined by their spin polarized metallic surface states that are protected from defects. This topological invariance is due to the surface states being occupied by Dirac fermions that are spin-momentum locked, which makes the material a promising candidate for future use in quantum computing. This study focuses on a new way to probe such surface states by creating devices from Bi2Se3 topological insulators with ferromagnetic contacts to measure how tunneling changes with applied magnetic field. Molecular beam epitaxy is used to create the Bi2Se3-In2Se3-Ferromagnet layers, photolithography and chemical/dry etching are used to create the devices, and resistance measurements are taken from 295 to 5K in a cryostat using a shunt resistor and an electromagnet. We hope to observe resistance shifts that are different from that of only Bi2Se3 tunneling devices and show the effect of the ferromagnetic contact. This work would help to show how ferromagnetic contacts can be used to more simply observe the spin momentum locking of TI surface states.