Intersections
Spring Symposium

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SENIOR CAPSTONE

RESEARCH AND CREATIVE PROJECTS BY UNDERGRADUATE STUDENTS INCLUDING SENIOR CAPSTONE STUDENTS

A Portable Urodynamics Stimulation System for Continuous Data Recording

Kelsey Aamoth, Biomedical Engineering

Persons with spinal cord injury often have hyperactive bladder contractions and a low bladder capacity as a result of the injury. Functional electrical stimulation of the genital nerve has been shown to improve these effects and improve the quality of life for these patients. To quantify these outcomes chronically, we have developed an ambulatory urodynamics system that can continuously monitor and record a subject's bladder pressure and provide electrical stimulation when needed. We have achieved this outcome by developing a carrier board to be added to an existing programmable stimulator UECU (Universal External Control Unit) that has very limited memory. The carrier board and UECU were programmed to be compatible with each other and allow for additional memory storage on an SD card located on the board. The UECU system was designed to receive two analog inputs that contain bladder pressure information and transmit the data to the carrier board. The additional memory improves the monitoring time from 5 minutes to a few months at a 100Hz-sampling rate. The system also allows for electrical stimulation of 20 Hz at a range of 0-60mA selected by the user. We have been able to use this device to record data in acute human experiments. In future work, this device will enable us to perform chronic experiments with quantifiable data and allow us to see bladder behavior in a more natural environment.

Project Mentor: Kenneth Gustafson, Biomedical Engineering

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Polyethylene Glycol and Polyoxazoline Effect on Second Virial Coefficient of Cowpea Mosaic Virus

Diana Acosta, Biomedical Engineering

Second virial coefficients are important for characterizing proteins through "soft" interactions. After using CG-MALS for successfully characterizing second virial coefficients of bovine serum albumin, we turned our focus to the icosahedral cowpea mosaic plant virus. Soft interactions are universal forces and are applicable to every day meso-scale interactions. These interactions include repulsions and attractions that are components of Van der Waals-London Dispersion forces. Furthermore, static light scattering is a fundamental tool for the characterization of biomolecules and their interactions, from which we are able to calculate the second virial coefficient of many biological materials. The correct reproduction of second virial coefficients through static light scattering will better our understanding of molecular interactions in important biomolecules. The manipulation of such interactions will provide major developments for nano-scale assembly applications in the fields of drug delivery, photovoltaic and optical ceramics. This research focuses on the understanding of Van der Waals forces; because of this focus we have concentrated on the isoelectric point of the cowpea mosaic virus, where we can isolate the Van der Waals force and study its strength. We have defined second virial coefficients of the cowpea mosaic virus at pH levels 4.6-6.5. This preliminary study led us to investigate the effects of chemically conjugating polyethylene and polyoxazoline to the surface of the virus in solution and observing the second virial coefficient. We studied such effects and found that conjugating polymer to cowpea mosaic virus improves virus resistance to aggregation at low pH. The results indicate that further study is warranted, and will be described. From our results we expect to compile a series of reputable data and form an understanding of how virus surface modification with polyethylene glycol compared to polyoxazoline affects important biomolecular interactions.

Project Mentor: Roger French, Materials Science Engineering

Investigating the relationship between muscle force and muscle activation with surface electromyography.

Veronica Adornato, College Prep

The goal of these experiments was to demonstrate the relationship between force and EMG. The experiments used surface electrodes to record the activity of arm and hand muscles during a pinching motion and bicep curls. The results were that the muscles directly involved in the action had a linear relationship with force and were the most active. Further experiments in the future can demonstrate even further the relationship between force and EMG and can be used to diagnose motor deficits.

Project Mentor: Natalie Cole, BME

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Multifunctional and Spatially Controlled Bioconjugation to Melt Coextruded Nanofibers

Abigail Advincula, Polymer Science and Engineering

Polymeric fibers have drawn recent interest for uses in biomedical technologies that span drug delivery, regenerative medicine, and wound-healing patches, amongst others. We have recently reported a new class of fibrous biomaterials fabricated using coextrusion and a photochemical modification procedure to introduce functional groups onto the fibers. In this report, we extend our methodology to control surface modification density, describe methods to synthesize multifunctional fibers, and provide methods to spatially control functional group modification. Several different functional fibers are reported for bioconjugation, including propargyl, alkene, alkoxyamine, and ketone modified fibers. The modification scheme allows for control over surface density and provides a handle for downstream functionalization with appropriate bioconjugation chemistries. Through the use of multiple orthogonal chemistries, fiber chemistry could be differentially controlled to append multiple modifications. Spatial control on the fiber surface was also realized, leading to reverse gradients of small molecule dyes. One application is demonstrated for pH-responsive drug delivery of an anti-cancer therapeutics. Finally, the introduction of orthogonal chemical modifications onto these fibers allowed for modification with multiple cell-responsive peptides providing a substrate for osteoblast differentiation.

Project Mentor: Jon Pokorski, Macromolecular Science and Engineering

Carbazole-assisted Electrodeposition of Graphene Oxide: Synthesis, Characterization and Directed Deposition

Paul Advincula, Polymer Science & Engineering

Graphene materials are an important class of nanomaterials useful for many applications including sensors, thin film electrodes, solid state devices, electromagnetic shielding, and heat conductors. The formation of thin films is important for these various applications and therefore needs optimization for fabrication and control of properties. In this work, we have derivativatized graphene oxide (GO) nanomaterials with electrochemically active carbazole (Cbz) groups to facilitate their electrodeposition or chemical redox properties. The nanoplatelets were first modified by the Cbz monomer using simple esterification procedures. The materials were then electrodeposited and characterized by spectroscopic techniques such as UV-vis, Fluorescence, X-ray Photoelectron Spectroscopy and Fourier Transform Infrared Spectroscopy. Imaging tools such as TEM, AFM, SEM were also utilized and electrochemical and thickness measurements were also performed. After their characterization, patterning methods will be attempted. The materials will be utilized eventually for solid state devices and sensors.

Project Mentor: Joay Mangadlao, Macromolecular Science And Engineering

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Robotic Implementation of Praying Mantis Predation Behavior as Observed through Artificial Cockroach Stimuli

Marcos Agaiby, Biology; **Anne Cardwell**, Biology; **Sarah Mastrandrea**, Mechanical Engineering

The hunting behavior of the praying mantis Tenodera sinensis has been widely investigated to define how the mantis moves and makes decisions (Corrette 1990). In this experiment we identified variables that impact decisions in specific hunting behaviors. Tests were run by placing a fasted mantis and 3 cockroach nymphs (prey) together in a 16" square arena and observing behavior with a high speed video camera. These live prey trials allowed for observation of natural hunting behaviors to determine if the mantis orients to the prey, pursues it, and eventually strikes it. These variables were narrowed down to the distance of the prey, direction of prey movement, speed of the prey, and position of the prey in the visual field. An artificial stimulus set-up was then used to manipulate the individual variables. An LCD (Liquid-crystal-display) screen was placed below an arena with a clear floor. A black oval simulating a cockroach was run in either a circular or linear path relative to the mantis' head in order to test each variable. This experiment was run in conjunction with a team of engineers developing robots to model the predator-prey interaction between adult praying mantises and cockroach nymphs.

The mantis robots are able to track and pursue moving targets (cockroach robots) using antennae to avoid obstacles and a new 360 degree field of view camera to search for colors indicating prey. Modifications to an algorithm that is based on observed insect behavior allow the new mantis robots to track, chase, and attack the cockroach robots. To better portray the praying mantis attack, an arm has been added to the mantis robot. This addition illustrates how the mantis strikes at prey, while also offering an opportunity for the prey to escape should the strike be unsuccessful. This version of the predator-prey robots will offer a more accurate simulation of the praying mantis hunting methods.

Project Mentor: Roy Ritzmann, Biology

Peanut Dust Nose: The Need and Design for an Airborne Allergy Detecting Device

Nikita Agrawal, BME; **Bryan Wey**, BME; **Daniel Schapira**, BME

Peanut allergy in the United States has an estimated prevalence of 0.6 – 1.3% [1]. In addition, peanut allergies for children in the United States has more than tripled between 1997 – 2008 [2]. Since there is no cure for the peanut allergen and the only solution is strict avoidance of food allergens, early recognition of peanut protein and management is the only sufficient route for those users affected by this allergy. As a result, it is really important to design a peanut protein detection device to protect the user from initial contact, acting like a "nose" to signify potentially harmful concentrations of peanut protein in the air. The main sections of the device should include a type of gathering system, one or more detection mechanisms, and an alarm. An alarm should be used to alert the user. Our goal is to design and build a peanut allergen detector that is portable, simple to use and kid-friendly. The device should provide quick and accurate results, ideally for airborne protein. If our goal is achieved, the device will be a useful tool that protects users with peanut allergies from the threat of an allergy attack by allowing them to safely exit the location before inhalation of the protein.

Project Mentor: Punkaj Ahuja, Biomedical Engineering

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Evidence for Self-Recognition in the Turkey Vulture (Cathartes aura)

Cara Anderson, BA Biology, BA Evolutionary Biology

The mirror self-recognition test, or MSR test, is a behavioral test to determine an animal's ability to recognize itself. The MSR test relies on the idea that if an individual is able to recognize its own body, it will be able to utilize a mirror to remove a mark placed on its body that it could not have seen without the mirror. As of today, a handful of mammals (including chimpanzees, elephants, and dolphins) have passed the MSR test, but only one non-mammalian species: the European magpie. The procedure for this study closely resembles that of the study performed on the European magpie by Prior et al. in 2008, who, among others, indicate that self-recognition is a characteristic often found in species with complex social understanding. Because turkey vultures (Cathartes aura) exhibit social interactions within roosts I hypothesized that they would take a significantly shorter amount of time to remove an out of sight mark when in the presence of a mirror than without a mirror, which would suggest the capacity for self-recognition in this species.

Two captive turkey vultures belonging to the living collection of the Cleveland Museum of Natural History were given the MSR test. Because these two individuals had been previously accustomed to mirrors, an additional standardized mirror exploration was performed on two captive turkey vultures belonging to the collection of the Penitentiary Glenn Reservation which had never been presented with a mirror. Results will be discussed in the context of other species that have successfully passed the MSR test and what is known about C. aura social behavior.

Project Mentor: Mark Willis, Biology

The Need for a Force Sensing Laryngoscope and its Applications in Clinical Research to Improve Standard of Care for Patients

Jake Anna, Biomedical Engineering; **Tony Zhang**, Biomedical Engineering; **John Todia**, Biomedical Engineering

Through EBME 380: Biomedical Engineering Design Experience, our team is developing a suspension laryngoscope that records the forces applied to patients during surgery. The goal of the project is to facilitate research that will establish baseline standards of pressure during laryngoscopies that result in unwanted side-effects such as numbness, tooth chipping and loss of taste. Force sensors encased in a silicon sheath are placed on the blade. Original circuitry and programming allow for collection and analysis of data. The long-term goal of the project is to reduce the adverse effects common in laryngoscopic procedures and improve the intraoperative standard of care for patients. Partners in this project include Cleveland Clinic Foundation researchers Dr. Paul Bryson, M.D. and Dr. William Tierney, M.D.

Project Mentor: Colin Drummond, School of Nursing

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Identifying PET/MRI Parameters for Early Treatment Response in Renal Cell Carcinoma

Jacob Antunes, Biomedical Engineering

An estimated 63,920 new cases of renal cell carcinoma (RCC) occurred in the US in 2014. For patients with RCC, tyrosine kinase inhibitors (TKIs) are becoming widely used in targeted therapy. Studies which have assessed RCC treatment response to TKIs have relied on changes in tumor growth using Response Evaluation Criteria In Solid Tumors (RECIST). As tumor growth changes appear months into the treatment regime, RECIST may not be able to identify early response to TKIs. Computer extracted feature analysis in conjunction with positron emission tomography/magnetic resonance imaging (PET/MRI) may better capture early treatment response. Our goal was to identify PET/MRI parameters that reflect functional changes indicative of early treatment response in RCC to TKIs. For 1 RCC patient, test/re-test and early treatment acquisitions of integrated PET/MRI acquisitions were obtained. Fluorothymidine was used as the PET radiotracer. Sequences considered in the study were PET, Diffusion Weighted Imaging (DWI) and T2-weighted (T2W) MRI. Deformable registration was performed between corresponding sequences across days. Computerized feature extraction was applied to obtain quantitative parameters, namely, standard uptake value (SUV, from PET), apparent diffusion coefficient (ADC, from DWI) and textural maps (regions of homogeneity and inhomogeneity, from T2W). Treatment change was evaluated on a per-voxel basis within the RCC. SUV, ADC, and top-ranked T2W texture Sum Average demonstrated consistent values between test/re-test, indicating low inherent variability in these parameters. After 3 weeks of TKI treatment, SUV, ADC and Sum Average values decreased 62.5%, 30.1% and 34.5%, respectively, within the RCC, reflecting lowered function. We have presented a quantitative image analysis framework to assess PET/MRI parameters for RCC treatment response on a voxel-wise basis. Quantified SUV, ADC and Sum Average parameters appear to be reflective of early changes due to TKI treatment.

Project Mentor: Anant Madabhushi, Biomedical Engineering

Enzyme activity and sodium absorption in summer and winter acclimated freshwater teleosts

Varsha Aravindabose, Biology and Medical Anthropology

To survive in a hypotonic environment, freshwater teleosts need to continuously absorb sodium (Na) through their gills. Many different mechanisms have been suggested to explain how teleosts are able to maintain Na homeostasis, however none have been thoroughly tested. Teleosts living in temperate environments must maintain Na homeostasis over a wide range of environmental temperatures (1-30°C). We hypothesize that Na absorption across the gills is driven by a protein homologous to a mammalian Na/H exchanger (NHE). To test this hypothesis, we will create gill membrane vesicles that contain a pH sensitive dye (BCECF) and measure changes in pH induced by different concentrations of Na. We will then incorporate an Na sensitive dye into the vesicles and measure changes in intravesicular Na in response to imposed pH gradients. These experiments will be performed in warm-acclimated (WA) and cold-acclimated (CA) fish, and maximum rates of transport and affinities for Na and H will be calculated. We found a Vmax of XXX and a Km of YYY. It is known that enzyme activity decreases with temperature; therefore, protein from the gills of CA should display higher enzyme activity than those from WA at any given temperature. We found that the Vmax of WA was GG and CA was HH. The Km's were BB and NN, respectively. We conclude that: 1) freshwater teleosts can absorb Na via NHE; and 2) CA fish have higher enzymatic activity than WA fish. The higher activity of NHE in CA may be a compensatory response to loss of activity caused by temperature.

Project Mentor: Dr. Jeffrey Garvin, Physiology and Biophysics

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Incorporating Expanded DNA Base Chromophores in E. coli: Potential Risks and Prospective Phototherapeutic Applications

Brennan Ashwood, Chemistry; Marvin Pollum; Steffen Jockusch; Carlos E. Crespo-Hernández

The unnatural base pair d5SICS-dNaM has recently been incorporated into the DNA of E. coli and demonstrates the unique ability to be conserved throughout the microbe's replication cycle (Nature 2014, 509, 385), effectively expanding their genetic alphabet. This base pair is currently under heavy investigation for its potential to transcribe unnatural amino acids to create new proteins and biotechnological applications such as site-specific labeling of amplified DNA. Both d5SICS and dNaM possess expanded ring systems, which typically allow for the absorption of long wavelengths of light. This characteristic is in stark contrast to the natural nucleobases, which are only able to absorb into the UVB region of the spectrum (280 to 315 nm), and are thus uniquely protected against much ambient light-induced chemistry. In an effort to determine if these expanded chromophore structures pose any potential light-induced threat when incorporated into cellular DNA, our group has begun to analyze their photophysical properties. We have determined that both bases absorb longer wavelengths of light and that d5SICS, in particular, has the ability to absorb visible light. We have further employed time-resolved spectroscopic techniques to determine the light-induced processes in these bases. Our results demonstrate that d5SICS exhibits high triplet yields and can efficiently generate highly reactive singlet oxygen upon visible-light absorption. The potential risks of incorporating these expanded chromophore DNA bases into living cells will be discussed as well as the possibility of using these unnatural nucleobases as sensitizers for phototherapy.

Project Mentor: Carlos E. Crespo-Hernández, Chemistry

Chemical fingerprinting of volcanic tuffs from the Afar, Ethiopia

Madeline Atkins, Environmental Geology and Environmental Studies

This research project adds to the understanding of the evolution of early humans within a geologic setting during the Miocene-Pliocene Epoch within the context of the East African Rift system. By gathering information on how our species has evolved through environmental changes, we can extrapolate as to how our species might be altered as a result of modern climate change. Volcanic tuff layers are geologically instantaneous events that can be used to identify time horizons within the geological record and enable us to correlate stratigraphic sections to specific times to reconstruct the landscape and paleogeography and provide context for the fossil evidence of vertebrate evolution. This project works on the analysis of volcanic tuff glass samples from multiple locations within Afar, Ethiopia to better understand the underlying strata of the area and to create a time record of human evolution and climate change. Volcanic glass compositions of twelve major and minor elements is determined by using the Electron Probe Micro Analyzer at the University of Wisconsin – Madison. Principle component analysis (PCA) is performed using Primer 6 software, along with the creation of paleogeographic maps, cross-sections, and stratigraphic columns. This project is funded through the CWRU Department of Earth, Environmental, and Planetary Sciences, The National Science Foundation, and the SURES program at Case Western Reserve University.

Project Mentor: Beverly Saylor, Earth, Environmental, and Planetary Science

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Quantitative analysis of electrolytic silver reduction by a plasma electrode

Amy Aube, Chemical Engineering

Electrolytic reactions such as the reduction of silver ions to solid silver are typically carried out by applying a voltage to metal electrodes submerged in an aqueous electrolyte. The reduction rate is measured by weighing the deposit on the metal electrode. This project studied the electrolytic reduction of silver ions by a plasma electrode. Current passes from a metal electrode, through a gas discharge, to the solution. Thus, reduction of silver ions results in clusters and nanoparticles that are freely formed in solution. To quantify the reduction rate, the weight of the silver nanoparticle product was measured, similar to the case of deposition on a metal electrode, but required that the nanoparticles were separated and dried. We performed the experiments and analysis over a variety of currents and times. From the measured weights, the efficiency of silver ion reduction was determined and compared to a theoretical value based on Faraday's laws. The results show that the plasma electrolytic process has an efficiency of about 80%, with the efficiency decreasing slightly as the current was increased. Details of the process and our working hypothesis for the inefficiencies of the process will be presented.

Project Mentor: Mohan Sankaran, Chemical and Biomolecular Enigneering

Binge drinking in depression: an event-related potential study of error related negativity

Zachary Azam, Psychology

Depression and alcohol abuse are highly likely to co-occur in early adulthood, and both are characterized by abnormalities in subject's affect, cognition, and motivation. However, relatively few studies have examined overlapping depression and alcohol abuse in relation to cognitive processing. One of the main cognitive controls associated with depression is error detection. Error related negativity (ERN) is an electrophysiological response observed when subjects commit errors, and is thought to be related to defensive reactivity and avoidance tendencies. Studies involving depressed or anxious subjects suggest that internalizing disorders are associated with more negative ERNs. As a result, many studies have sought to further understand how depression may elicit its affects on this response. However, there is little research on how the ERN might interact with emotion regulation strategies or with binge drinking. Thus, goal of this study was to explore how ERN might be sensitive not only to depressive symptoms but also to binge drinking practices and emotion regulation strategies. Based on previous findings, it was hypothesized that depressed individuals who were also binge drinkers would have greater error related negativities and would engage in poor emotional regulation strategies. The current study examined thirty-seven subjects who self-reported levels of depressive symptoms on the Center for Epidemiological Studies Depression Scale and binge drinking, as well as emotional suppression, reappraisal, and rumination. Furthermore, subjects participated in a cognitive flanker task designed to trigger the error related negativity while event-related potentials were recorded. Repeated-measures analysis of variance indicated a multiple interactions between ERN amplitudes, depressive symptomology, binge drinking, and reappraisal. Binge drinking predicted less negative ERNs for depressed participants, as did reappraisal, while suppression predicted more negative ERNs.

Project Mentor: Arin Connell, Psychology

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Redesign of Intravenous Catheters to Improve Peripheral Blood Draws

Makenzie Best, Biomedical Engineering; **Kelly Buchanan**, Biomedical Engineering; **Jonathan Duff**, Biomedical Engineering

The purpose of this project is to redesign an intravenous catheter to make peripheral blood draws more successful and a better experience for both patients and nurses. The current IV catheters can cause hemolysis, where the blood cells are damaged; requiring additional needle sticks to a patient to redraw. The considered redesigns include several factors, such as a curved edge and a hole in the catheter, to reduce the risk of hemolysis occurring, leading to improved hospital efficiency, especially in the ER, and improved patient satisfaction.

Project Mentor: Colin Drummond, Biomedical Engineering

Release study of oxidative stress and pH dyes in salt-leached sponge scaffolds

Morgan Bolger, Biomedical Engineering

A common cause of blindness is degeneration of retinal pigment epithelium and photoreceptor cells known as age-related macular degeneration (AMD). AMD affects approximately 30 million people worldwide. The number affected is expected to double by the year 2020 due to an increasing aging population [1]. The delivery of different types of stem cells has demonstrated the capability to restore vision but the specific stem cell types and deliver methods are still being researched [2]. Theoretically, if the stem cells absorbed dyes or makers, the stem cell behavior during implantation would provide information that could further the development of stem cell therapies to counter retinal degeneration. This study examines the use of salt-leached poly(lactic-co¬-glycolic acid) (PLGA) and polylactic acid (PLA) scaffolds to characterize the release of pH and oxidative stress dyes over time with PLA and PLGA scaffolds of different molecular weights.

Project Mentor: Erin Lavik, BME

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Design For America CWRU + CIA: Tackling local and social problems with Human Centered Design.

Marc Bouchet, Materials Science ENGR and Aerospace ENGR

Design For America is a national student organization focused on using human centered design thinking to solve local and social problems. We are part of a network of over twenty university-based studios developing the next leaders, change makers, and entrepreneurs by merging interdisciplinary work with design thinking to solve problems in new and impactful ways.

This semester has been an exciting mix of new starts and continuing initiatives for DFA CWRU+CIA, with the creation of a design sprint program to help fast-track new members into the design process, combined with teams moving into their second semester of ongoing projects throughout the Cleveland area. We're pumped to be running seven total projects, with partners ranging from the Cleveland Clinic to the Cleveland Children's Museum, from a studio of 43 members, hailing from 16 different majors and 3 different schools. Building on our strong faculty foundations, we're stoked to be collaborating with guests from all over our campus to work with us on talks and workshops. Kicking it off last week was Lee Hoffer, associate professor of Anthropology at Case Western, who helped us peer deeper into the world of user research by drawing on his work with drug users and high-risk populations. Up next is a visit from the design firm Nottingham Spirk – creators of Swiffer, Purell, and the electric toothbrush – to help design sprint teams with ideation, and down the road we are excited to host Malcolm Cooke for the second year in a row with a workshop on moving from concept to prototype.

We intend to present the progress of our teams working on solving issues in healthcare, children's development, and recycling.

Project Mentor: Patrick Crago, Biomedical Engineering

The Effects of Domestic Violence Education in Nicaragua

Kathleen Broderick, Nursing; **Lena McCoy**, Nursing; **Eileen Johnson**, Nursing

Viejo Norte, Northwest Nicaragua is the most rural part of Nicaragua on the Pacific Coast. Many people are impoverished as there are many day laborer men and stay at home mothers who run the household. Hard physical labor is the norm for both genders, as women will haul heavy gallons of water and chop firewood daily. Education is optional and not a priority. Many children will be pulled out of school to help their parents on the farm or sell things like bread or clothing, in the city.

Like most Latin American countries Nicaragua is a very machismo society. Machismo is an attitude of men being very strong, courageous, aggressive, and the dominant sex. This attitude attributes to high rates of domestic abuse. One in three women will be victims of domestic violence in Nicaragua (Canada, 2010). The nursing students witnessed a patient who was a victim of domestic abuse first hand when she came to the clinic looking for help. The students also heard about the history of violence in the society from locals and saw other patients coming to the clinic looking for a way to escape their homes. The students decided to research the issue in Nicaragua and were able to meet with many people who also share an interest in decreasing violence.

When looking at this list of factors of violence it is easy to see why a place like Nicaragua could have a problem with domestic violence. Police reports from the area say that 34% of all the crimes in the last year involved domestic abuse (Moloney, 2013). About 900 cases a month or 30 cases a day of domestic violence are also reported to the police in Nicaragua (Abbott,2011). After learning these facts the nursing students decided to work against domestic violence in the community.

The project focused on decreasing the violence occurring in the communities. The nursing students wanted to accomplish this through educating the community on types of violence, resources to get help if you are being abused, and signs and risk factors of

Project Mentor: Dr. Marilyn Lotas, Bachelor of Science in Nursing

Assessing Patient Exposure to Transport

Kathleen Broderick, Nursing

This summer I was given the opportunity to work with Dr. Reimer and the Cleveland Clinic Critical Care Transport team to assess the patient exposure to transport. Patients are transported each year from hospital to hospital for more specialized care or better facilities. This transport is usually done by helicopter or ambulance. My project focused on the effects of external stressors on the patient during transport. With the help of Dr. Reimer and the CCT team I was able to travel with these patients to do this research. This opportunity allowed me to work on my project in the best way possible as well as see a new side of critical care nursing. A field I am highly interested in.

Previous studies have been done looking at vibrations and sound on patients in transport. A study using a device that measured acoustic noise, whole body vibrations, and ECG on infants being transported by ambulance or helicopter showed that the noise levels greatly exceeded the recommended limits. There was also an increase in whole body vibrations, which was linked to a lower heart rate (Karlsson 151). The heart rate variability of these infants was also statistically significantly higher at the end of transport compared to the beginning (Karlsson 151). This means that the infants had a wider range of high and low heart rates being recorded at the end of transport. Data has also been collected on the effects of mechanical stressors, vibration and noise, on neonates using ambulances and helicopters. After focusing mostly on the movement of the vehicles themselves showed that helicopters had overall higher rates of whole body vibrations and noise (Bouchut 139).

With these studies indicating a further need to look at environmental stressors during transport Dr. Reimer was able to develop a multi- sensor unit that looked at multiple areas of environmental stress during transport: barometric pressure, vibration, noise, and temperature. Each sensor in the unit then records data at a rate of

Project Mentor: Dr. Andrew Reimer, Instructor, Post-Doctoral Fellow

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Snail population dynamics in seasonal habitats.

Gavin Brown, Mathematics

Snail species are intermediate host for Schistosomiasis transmission, with parasite circulating between human and snail hosts via larval stages. Clearly, snail population dynamics and infection plays important role for accurate prediction of Schisto transmission and control. Field data from Kenya used in our study shows snail populations and their habitats undergo strong seasonal variations, following rainfall. In this study, we developed dynamic snail population model in such habitats. Snail populations are described by spatially distributed densities of its two stages (young-adult). The basic mechanisms in our system include population biology (growth/replication, maturation, resource competition), as well as snail mobility in response to changing habitat (spread/contraction). The model has two components (i) dynamic habitat driven by precipitation and loss (evaporation); (ii) dynamic snail populations competing for resource.

The model was calibrated and validated using field data collected in Coastal Kenya, where seasonal rainfall is the principal driving force of changing and snail growth.

It will be further extended to include snail infection, and applied to Schistosomiasis transmission and control.

Project Mentor: David Gurarie, Mathematics

A Single-use, Disposable, In Vitro Platinum-Based Biosensor for the Detection of Extremely Low Level Nitric Oxide in Aqueous Medium

Samantha Butler, Chemical Engineering

Detection of nitric oxide at extremely low level in aqueous medium was accomplished using a single-use, disposable in vitro electrochemical platinum-based biosensor. This biosensor was fabricated by laser ablation micro-fabrication technique resulting in a cost effective, highly uniform biosensor suitable for single-use, disposable in vitro applications. This biosensor is coated with a membrane consisted of a Nafion (an anion selective membrane material made by Du Pont) solution and Nickel II porphyrin providing the selectivity of NO from the aqueous medium for detection. NO, in an aqueous sample has a very short half-life, i.e. 16 minutes; therefore, special preparation of NO in the aqueous test samples was needed Thus, for testing and evaluation of the biosensor performance, DEA NONOate was added into 1mM NaOH solution forming different concentrations of the Nitric Oxide contained aqueous testing samples.. Phosphate Buffer (pH=7.3) was used to liberate the NO molecule from the DEA NONOate during the testing. The biosensor was connected to a CHI 660A or a handheld CHI 121.B Electrochemical Workstation and the testing was carried out in an Argon-rich test chamber. The testing sample was then placed on the surface of the biosensor, and approximately 10-15 ?L (less than one drop of blood or other physiological fluid sample) Differential Pulse Voltammetry (DPV) measurement technique was employed in this testing. Our testing results showed that we can measure NO as low as 0.01127?M in an aqueous sample. This is a revolutionized development, for a single-use, disposable in vitro biosensor for NO detection at this low level has never succeeded, and this is the first biosensor to achieve this goal.

Project Mentor: Chung-Chiun Liu, Department of Chemical & Biomolecular Engineering

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Improving Knowledge on LARCs in the Young Adult Female Population in Cuyahoga County

Brianna Cain, Nursing; **Lindsey Clint**, Nursing

In the United States, half of all pregnancies are unplanned, equaling about 3 million unplanned pregnancies a year (Winner, 2014). Forty percent of these unplanned pregnancies result in 1.2 million abortions a year (Winner, 2014). Oral contraceptives, which range from 92%-99% effective when taken exactly as directed, are currently the most used form of birth control in the United States. Long acting reversible contraceptives (LARCs) are the most effective form of birth control (99%) and require no daily or monthly action of the user. There are currently three forms of LARCs, a hormonal implant which is placed subdermally in the females upper arm on the non-dominant side, a hormonal intrauterine device and a non hormonal intrauterine device. This project focuses on determining what the current perceptions are of LARCs in the female population ages 17-24, and the main barriers to their use in the United States. The demographics of our population focused specifically on young adult females of Case Western Reserve University. We determined that a lack of health care provider recommendations contributed to a lack of knowledge and hindered the use of LARCs. In an effort to combat the lack of knowledge, we enacted several community outreach endeavors. One such endeavor was the distribution of clinic and LARC information to local food pantries, as well as other colleges in the area. Educational flyers were created and distributed, and proven effective within our focus groups as evidenced by the post test results. Continued education in the community and encouraging healthcare providers to discuss LARCs as an appropriate option of birth control are the beginning steps for furthering the promotion of LARCs in the United States.

Project Mentor: Mandisa Molton, Nursing

Limitations of Nonlinear Analysis for Highly Periodic Time Series

Alex Cao, Applied Mathematics

Dhingra et al. 2011 introduced a new technique for detecting increases in deterministic variability in signals. Using the traditional surrogate data generating algorithm, Iterated Amplitude Adjusted Fourier Transform (iAAFT), along with sample entropy and mutual information, metrics relying on a choice of a time-shift parameter tau, Dhingra quantified the variability in the respiration signals of rats. Previously, these metrics used a single value for tau, but Dhingra averaged across a continuum of tau values. Dhingra calculated changes in deterministic variability between two different signals: respiration signals of rats who had undergone a vagotomy (lower deterministic variability) and the same signals of rats who hadn't (greater). Our initial goal was to create a computational model to mimic his experiment and analysis. We replaced the neural oscillations of the neural-respiratory model from Diekman et al. 2012 with the well-known Rössler system. During simulations, we found that iAAFT can be very inappropriate when used with highly periodic, sinusoidal time series like that of respiration signals. Due to those signals being comprised of two near-power and near-frequency sinusoids, the surrogates contain what we've dubbed "pinching"; an artifact of iAAFT's algorithm. We then repeated Dhingra's methods using a new surrogate algorithm we developed, the Cycle Adjusted Transform (CAT). It works by randomly shuffling periods within signals. After demonstrating that CAT is more consistent than iAAFT, we applied Dhingra's analysis methods to the lung volume signals from our new Rössler-Diekman system. Contradicting Dhingra's results, from a periodic to chaotic signal, imitating the vagotomy experiment, we couldn't detect changes in the deterministic variability using CAT with sample entropy or mutual information. Ultimately, we conclude that the behavior of surrogates is not clear with respect to changes in deterministic variability in the original signal.

Project Mentor: Professor Chris Fietkiewicz, EECS

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Pharmacist-Patient Counseling: Medication Adherence in Elderly Populations

Rachel Cartus, Chemistry

Medication nonadherence is a growing problem in older populations as prescriptions become more complex and more important for maintaining health. Consequences of nonadherence in older adults can be more serious than in younger populations because they are more difficult to notice and resolve . Common reasons for nonadherence in the elderly include concern for potential side effects, fear of addiction, and more importantly, cognitive decline and the complexity of regimens. Because they often live alone and are hesitant to visit physicians, pharmacists are frequently the most accessible health care providers for the elderly. Communicating with patients in a comfortable setting such as local pharmacies may help to improve the elderly's adherence to medication regimens. While efforts to improve the adherence to prescription medication are multi-disciplinary, pharmacists play an important role in improving adherence. My research explores the communication aspects of pharmacist-elderly patient counseling. I examined formal and informal dialogue, effective counseling techniques, and nonverbal factors associated with counseling. Results suggest that characteristics of pharmacist dialogue can influence patient adherence. I summarize some of the problems associated with communicating with the elderly and provide strategies and recommendations that can improve their medication adherence. The role of the pharmacist can be extended in many different directions to help improve medication adherence and thus the overall health of the elderly. Suggestions for interacting with patients and ideas for future research are included.

Project Mentor: Dr. Kathryn Rothenberg, Psychological Sciences

Extruded Polymer Nanosheets: Towards Mass Production of Polymer Nanosheets

Yvonne Chappell, College Prep; Al de Leon; Peng-Fei Cao; Kezhen Yin; Eric Baer; Rigoberto C. Advincula

Polymer nanosheets have found several applications as adhesive plaster, drug delivery, and separation membrane. However, major thing that limits its industrial application is that existing fabrication techniques can only fabricate it one at a time. This study investigates the applicability of the CLiPS technology to mass produce polymer nanosheets by co-extruding a water insoluble polymer and a water soluble polymer into a multilayer film. The dissolution of one of the layers will exfoliate the polymer nanosheets. It has been found that the extruded polymer nanosheets have higher mechanical property than the conventional spin-casted polymer nanosheet.

Project Mentor: Al De Leon, MSE

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In-Flight Tablet Stabilization Device

Paul Chariou, BME; **Michael McBurrney**, BME; **Ryan Currie**, BME

The Frances Payne Bolton flight nursing center is developing a full-scale simulator to train Acute Care Nurse Practitioners to care for critically ill patients being transported in helicopters. FPB has secured a Sikorsky S76 A fuselage outfitted with an EMS interior, modified to provide all of the visual, audio, and physical cues for an in-flight situation. To add to this simulation device, our group is focusing on the incorporation of electronic medical record keeping in flight. As regulations for medical record documentation begin to change, this presents an increased need for new and innovative technologies to fill this gap.
Our idea tackles an an initial design of such a device, taking the shape of an attachment and stabilization system for a tablet so that it can be used easily in flight. The device has been designed with user specification in mind to mitigate vibrations and other forces experienced while the helicopter is in motion. The current iteration of the design focuses on mechanical aspects of the device, with further iterations to cover additional advancements in electronic and communication concerns.

Project Mentor: Colin Drummond, BME

Modification of CFTR gene to express the R117H mutation in human immune cells using the CRISPR/Cas9 system

Michelle Chen, Biochemistry

Cystic Fibrosis (CF) is an autosomal, recessive genetic disease that affects approximately 70,000 individuals worldwide. The disease is caused by a mutation on the Cystic Fibrosis Transmember conductance Regulator (CFTR) gene and affects the lungs, pancreas, intestines, and other bodily organs. There have been almost 2,000 different disease-causing mutations that have been identified. This project focuses on the R117H mutation located on Exon 4, which accounts for less than two percent of CF patients. While the majority of CF research focuses on the lungs because many patients die from lung infections, it has been suggested an impaired immune system due to CFTR mutations is a contributor to these infections. In this project, we attempted to confer the R117H mutation into an immortal human monocyte cell line using the Clustered Regularly Interspaced Short Palindromic Repeats/Cas9 (CRISPR/Cas9) system described by Mali et al (2013). Following transfection of the cells, we characterize the cells using PCR and gene sequencing to determine whether the correct mutation was created. Out of 32 clone lines created, none contained any mutation on Exon 4.

Project Mentor: Mitchell Drumm, Genetics

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Environmental Attributes of the WERC Center

Sharon Chen, Materials Science & Engineering; **Robert Bishop**, Aerospace Engineering

Wind energy is a leading source of alternative energy due to the impact wind turbines have on the Ohio community. In order to test and develop new innovations for the Ohio wind energy market, the industry needs to utilize testing on varying sized wind turbines. The Ohio Wind Energy Research and Commercialization Center (Ohio-WERC) runs three different turbine size turbines to collect data and potentially to improve current wind turbine designs: a 100kW Northwind 100, a 225kW Vestas V27, and a 1.0MW Nordex N54. These three turbines are being used to develop new technologies, in addition to producing clean, renewable energy.

This study aims to quantify the environmental impact on Cleveland and Ohio as a whole from the wind power research that Ohio-WERC has been conducting. This study compares the net energy generated by each turbine on a yearly basis and examines the environmental attributes that come with using this technology.

Project Mentor: David Matthiesen, Materials Science & Engineering

Complications with infections in Kidney Transplantation

Soo Chung, Biology

Solid organ transplantation is one of the most effective therapy for many human diseases in the liver, kidney, heart, and lung. Transplantation for the end-stage diseases in these organs has become standard therapy, and the quality of life and survival rates after an organ transplant have greatly improved due to advances in surgical technique, immunosuppressive therapy, and medical management afterwards. However, pre-transplantation and post-transplantation infections have been major concerns and causes of morbidity and mortality regarding organ transplantation. A common tactic to reduce organ transplantation rejection is the immunosuppressive therapy using immunosuppressive medications, increasing susceptibility to pathogens and infections, including bacterial, viral, fungal, mycobacterial, and parasitic infections, remain to be an enormous concern for transplant recipients. Some success in preventative measures and medications have proved to be successful in treating of various infections. New anti-fungal agents will hopefully reduce the high mortality rate of mycelial fungal infections, while prophylaxis for these infections may also be used for treatment. Introduction of new practice such as xenotransplantation also has a high possibility of changing the epidemiology of infections and further research on treatments to accommodate for the changing epidemiology of infections is needed.

Project Mentor: Diane Kube, biology

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Multiple-way epistatic effects on genes effecting Tuberculosis susceptibility.

Natascha Cirignani, Biology

For my research project I am studying the epistatic effects between various genes on Tuberculosis susceptibility. This is done through the use of a computer program called ViSEN which helps model the interactions between genes. This program gives a visual representation of the genetic interactions using bars to represent two-way interactions and triangles to simulate any three-way epistasis. The genes studied have been previously discovered to be contributors of tuberculosis. In addition to looking at genetics I also include environmental factors such as infected family members, age, and tribe into the simulation.

Project Mentor: Karen Abbott, Biology

Cyclodextrin Hydrogels for The Controlled Release of Antimicrobial Agents for Poly-Microbial Device Infection

Sophia Colevas, Biomedical Engineering

Surgical site infections are the second most common adverse surgical event. While many infections can be treated effectively with systemic antibiotics, when delivered systemically, many antimicrobial drugs require higher dosing. Higher drug concentrations of commonly used antimicrobial agents can have increased cytotoxicity and lead to increased risk of antibiotic resistant infection. Formation of bacterial biofilm on a device surface leads to greater resistance to antibiotics. Medical device infections frequently involve a number of different micro-organisms (poly-microbial); therefore, broad spectrum agents are necessary for the prevention of infection and possible device failure. The focus of this study is the development of a controlled release system of broad spectrum antimicrobial agents using a cyclodextrin based drug delivery platform. Cyclodextrin hydrogels were synthesized using ?- or ?-cyclodextrin polymer crosslinked with hexamethylene diisocyanate (HDI) and loaded with one of three commercially used antimicrobial agents, Triclosan (TCS), Chlorhexidine (CHX) or Zinc Pyrithione (PYR) using a common solvent swelling method. Loading efficiency, drug release kinetics and antibiotic activity were measured for each drug/polymer combination. CHX and PYR loaded gels demonstrated moderate activity against Staphylococcus aureus and some degree of sustained release. TCS loaded gels showed considerable activity against S. aureus for an extended period of six months, sustained release for at least the industry standard of 30 days, and significantly reduced S. aureus biofilm formation, indicating that a cyclodextrin coating loaded with TCS would be extremely useful in preventing infection of an implanted medical device throughout the healing process.

Project Mentor: Horst von Recum, Biomedical Engineering

Safety and Efficacy of Ivermectin Human and Animal Multi-dosing Regimens; A Review.

Katirina Coppolino, Biochemistry; **Nikhil Mallipeddi**, Biology

Ivermectin, well documented as an anti-parasitic medicine, is widely distributed in major third world countries as a cheap and effective method of parasitic inoculation, and is listed as vital on the "World Health Organization Model List of Essential Medicines." In the United States today, Ivermectin is federally approved as single-dose drug for oral doses. In response to federal Ivermectin restrictions, we sought to categorize the documented instances of Ivermectin multi-dosages in the clinical research setting.

We conducted a literature review through the National Library of Medicine's PubMed database. Using the search terms "Ivermectin," we identified 5072 articles. Of these 5072 articles, those pertaining to multi-dosages were identified and 20 were incorporated into this review. The literature reviewed displayed the efficacy of Ivermectin multi-dosage. For example, published research documents effective multi-dosing of Ivermectin ranging from multiple, weekly 400 ug/kg doses to daily administered 10mg daily doses, all of which efficiently cured the parasitic ailment. Furthermore, amongst multi-dosage studies reviewed, patients exhibited no pertinent side effects. These multi-dosage results were replicated in animal models. Rats given water containing 48 mg/L of Ivermectin over a three day period, sprayed on weekly by a 0.1% Ivermectin solution, and even daily ingestion of 3 mg/kg over a ten day period displayed little to no side effects. Relevant studies performed in cats, pigs, and horses also showed no adverse side effects upon Ivermectin exposure. Published research outlines a high anti-parasitic success rate, where a majority of clinical studies resulted in complete eradication of the parasitic ailment; and a lack of adverse effects with Ivermectin multi-dosing both in animals and in humans. Therefore, we assert that Ivermectin is ready to be considered as a potential multi-dosing alternative to current treatment standards.

Project Mentor: Johnathan Sheele, MD, MPH, Medical School- Emergency Medicine

Blood and Saliva Samples to Help Develop a Rapid Diagnostic Test for Bed Bug Bites.

Katirina Coppolino, Biochemistry; **Nikhil Mallipeddi**, Biology; **Shruthi Mothkur**, Biology

Bed bugs are parasitic insects that primarily feed on blood from human hosts. Bed bug infestations cost the United States $3 million annually and bed bug necessitates the closing of hospital rooms for 17 hours for fumigation. The emergency department is the point of entry for the bugs. In the emergency department, this can significantly increase patient wait times due to room availability, cause a loss of hospital revenue, and threaten the provision of health services.

In this study, 40 participants were subjected to 4 visits in which they were fed on by three adult male bed bugs and blood and saliva samples were taken. An additional two visits at 3 and 6 months occurred to analyze long term effects of the bites. Analysis of human blood and saliva samples before and after a bite can determine if specific detection and characterization of an immunological response to the Bed Bug bite are possible. On visit 4, using D-squames tape, skin samples were collected in order to analyze the mRNA expression levels at the site of the bite, and this will provide information into how the body responds to bed bug bites. Cytokine levels were analyzed in blood correlation with rash presence and rash characteristics in participants. An enzyme linked immunoassay will be developed in order to perform a rapid diagnostic test in response to detection of immunoglobulins associated with the bed bug antigen. Another route is also explored in a PCR-based assay to detect bed bug DNA in participant blood, saliva, and skin.

These factors along with tracking the rash associated with the bite allow for the potential to develop a rapid diagnostic test that can identify the immunological responses to detect the presence of bed bug bites prior to emergency department entrance. This has the potential to deter bed bug spread throughout hospitals and for rapid identification of in-home infestations allowing for the prevention of further spread.

Project Mentor: Johnathan Sheele, MD, MPH, Medical School- Emergency Medicine

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Implementation of Health and Wellness Focused After-School Enrichment Programming led by Undergraduate Nursing Students in the Cleveland Metro School District

Amanda Crow, Nursing

Within the Cleveland Metro School District (CMSD), many schools struggle to meet the academic and social needs of their students. As a result, the district has seen repeated poor academic performance, low rates of attendance, minimal family involvement, and decreased student engagement in the school setting. Seeing this disparity, and realizing the need for social and academic services, United Way of Greater Cleveland developed the Community Wrap-Around Initiative for Academic Achievement. The program identified 17 schools within CMSD as most in need of academic and social support, and whose students would benefit most from the initiative. The program called for improvement in academic achievement, community health support, and socially responsible individuals to assist with the workload; leading to the development of a program at H Barbara Booker Elementary School. Through the implementation of after-school and out-of-school enrichment programming, an after school health education and physical education workshop program was implemented. By utilizing undergraduate nursing students as instructors and workshop leaders, their knowledge of health and wellness can provide the social and academic resources needed. In providing this resource, the physical, social, and emotional health of students is supported, and they are encouraged to learn in an environment that is both safe and supportive.

Project Mentor: Dr. Marilynn Lotas, PhD, RN, FAAN, Frances Payne Bolton School of Nursing

Controlled Delivery of an Antibiotic Using a Localized Affinity Change in Bacterial pH

Erika Cyphert, Biomedical Engineering

Erythromycin is an antibiotic drug frequently used in the treatment of Staphlyoccoccus aureus infections. Current treatment for these infections involves using high dosages of antibiotics over various periods of time. Due to the instability of erythromycin in acidic conditions and related gastric side-effects, a system that can preferentially deliver erythromycin to acidic bacterial conditions and minimize inactive conversion in acidic conditions is desirable. In an effort to increase the affinity interactions between the drug and an affinity-based polymer system, a high affinity adamantane linker was chemically added to erythromycin. In the presence of an acidic bacterial infection, the pH-sensitive bond formed between the linker and erythromycin is cleaved resulting in the release of active erythromycin. Through a zone of inhibition assay, the modified drug demonstrated the ability to inhibit the growth of bacteria over a similar time frame as the unmodified drug. Thus indicating that the chemical modification does not alter the intrinsic ability of the antibiotic to inhibit the growth of bacteria. Fourier transform infrared spectroscopy was used to confirm the correct synthesis of the modified drug. In order to determine the acidic chemical conversion process of each drug in solution, ultraviolet spectrum scans were obtained over different timelines. It was determined that the acidic conversion of erythromycin was reversible upon neutralization. The effects of the high affinity group were analyzed in two identical drug release studies in neutral and acidic conditions with the drugs loaded in affinity and non-affinity based gels. The studies confirm similar drug release profiles of unmodified drug in neutral and acidic conditions and an initial increased drug release profile of modified drug in acidic conditions compared to neutral confirming the effects of the pH-sensitive linker.

Project Mentor: Horst von Recum, Biomedical Engineering

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Study of Diamond and Lonsdaleite Nucleation

Olivia Dahm, chemical engineering

Diamond is of great interest in many fields because of its excellent properties. This research is focused on the nucleation of Lonsdaleite, a material that is very closely related to diamond. In both diamond and Lonsdaleite, each carbon atom is surrounded by four tetrahedrally-placed carbon atoms in the nearest-neighbor positions. The two lattices differ in the positions of the next nearest-neighbors; in diamond the resulting lattice is cubic, in Lonsdaleite the lattice is hexagonal. Theory shows that the energies and densities of the two forms are almost identical. It is not currently possible to nucleate Lonsdaleite, and therefore it is a much understudied substance. The goal of this research is to explain why, in nature and in both high-pressure and low-pressure synthesis, cubic diamond always forms rather than Lonsdaleite. We are attempting to nucleate and grow Lonsdaleite by using similar crystals such as wurtzitic boron nitride (w-BN) as seed crystals. The nucleation and growth experiments will be performed in a microwave-plasma diamond deposition reactor.

Project Mentor: John Angus, chemical engineering

Novel Approach to Identify Skeletal Muscle Mitochondrial Disorders

Dhweeja Dasarathy, College Prep

Background. Mitochondrial respiratory chain disorders result in reduced expression and/or function of electron complex chain components (ETC) with impaired ATP production and skeletal muscle disorders. Diagnosis requires quantifying enzyme activity of different complexes that is difficult, expensive and not universally available.

Hypothesis. Quantifying mitochondrial respiratory chain complex proteins by immunoblots assay is a rapid and precise method to diagnose mitochondrial myopathies but the commercially available antibodies have not been validated. Subjects and Methods. Total protein from ~50 mg vastus lateralis muscle biopsies from 10 patients with muscle weakness due to suspected mitochondrial myopathies was extracted and expression of the ETC components by immunoblots and activity by enzyme assays were determined. The antibody was validated using immunoblots and immunoprecipitation and rat skeletal muscle was used as a positive control.

Results. Expression in arbitrary units (AU) of complex IV (5.24±1.) and V (2.73±1.08) was high demonstrating greater expression of these complexes. In contrast, expression of complexes I (1.1±0.54AU) and II (0.42±0.39AU) were low in all subjects and required either higher exposure times (? 30 sec.) or a larger (?10?g) protein amount loaded. Complex III expression was (2.4±1.3AU). Simultaneous enzyme activity assays showed a high correlation ($r2=0.59$; $p<0.000$) by densitometric quantification.

Conclusions. Evaluation of protein expression by immunoblots and enzyme activity of mitochondrial respiratory chain can be done simultaneously in human tissue, and immunoquantification correlated with the activity of the complexes. This novel and simple approach can help identify specific respiratory chain complex defects and lay the foundation for identifying molecular therapeutic targets.

Project Mentor: Charles Hoppel, Pharmacology

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Project Mentor: Charles Hoppel, Pharmacology

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Modality-specific attentional shifting in rats.

Emma Dauster, Biology

Our cognitive state dramatically alters the way in which we perceive the world. One facet of cognition is attention: the ability to filter out irrelevant sensory information in order to focus upon a select modality. We have developed a paradigm that allows for recording from neurons in the olfactory cortex of rats, as they engage in a task, which manipulates attention. From these recordings, I aim to determine whether rats can more readily switch attention between olfactory and somatosensory stimuli or between olfactory and auditory stimuli. I predict that rats will readily attend to odors over all other stimuli, specifically tones and air puffs to the whiskers. Furthermore, I predict the transition of selective attention between olfactory and somatosensory stimulation will be much more rapid and thus less cognitively demanding than the transition between olfactory and auditory stimulation. Experiments are currently underway to test these specific hypotheses. The results of these experiments will yield a better understanding of neural processing of sensory information. Further, these results will have implications for understanding neurological conditions characterized by sensory processing deficits.

Project Mentor: Daniel Wesson, Neurosciences

Bed Fall Scenario Response System for Nursing Homes

Kishan Desai, Biomedical Engineering; **Martin Gitomer**, Biomedical Engineering; **Kenneth Gibbons**, Biomedical Engineering

This project focuses on the application of bed fall prevention in nursing homes while considering the strict regulations on restraints. A large number of falls that occur in nursing homes are due to the toileting issues prevalent in nursing home patients. This is especially seen in patients who are incontinent and have other physical constraints. The goal of this project is twofold. First, this project aims to develop a device that fastens a commercial off-the-shelf commode to the bedside to add stability and help patients support themselves when getting out of bed. This would also allow the patient to toilet in case of emergency. Second, the project will involve the development of an effective wristband alert system that signals nurses when patients are getting out of bed. This device would allow nurses to respond to patient motion quickly. Both devices will be designed with the intention of implementation in the Judson Bruening Health Center to improve the quality of care for patients.

Project Mentor: Colin Drummond, Biomedical Engineering

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Utilization of Melting Curve Genotyping to Correlate Allele Pairs in the Vesicular Monoamine Transporter Gene to Addiction.

Charlotte Doody, College Prep

Recent studies correlated specific allele pair combinations in the vesicular monoamine transporter gene, a gene essential for dopamine synaptical vesicle transport, to alcohol abuse. Our study tested the accuracy and effectiveness of Hybprobe melting curve analysis technology in identifying single nucleotide polymorphisms (SNPs) in the human VMAT gene. Genomic DNA were harvested from both control and addict subjects and genotyped by melting curve analysis using Roche LightCycler 480. Roche LightCycler® 480 System performed PCR and melting curve genotyping to determine the base pair alleles in each DNA sample. The base pair allele combinations we examined were G/G and C/C, located in the promoter region of the VMAT gene. Our results show that this method is efficient, reliable and cost effective in identifying SNPs in humans genetic DNA. We analyzed a total of 44 DNA samples collected from both addicts and control subjects. The percentage of control subjects that had G/G and C/C allele pair combinations was approximately twice as large as the percentage of drug-addict cases that had the same allele pair combinations. Only 2 of the 19 or 10.50% of the drug-addict cases had G/G and C/C base pair alleles in the VMAT gene, while 5 of the 25 or 20.00% of the control patients had the G/G and C/C base pair alleles. The higher percentage of G/G and C/C allele pair combinations found in control subjects in comparison to that of addicts is consistent with previous finding that this combination of G/G C/C base pair alleles in VMAT gene might be protective in addiction. Further study is needed to confirm this association using much larger sample size. For our study we have derived human induced pluripotent stem cells (iPS) that carry a variety of alleles for these polymorphisms. In vitro differentiation of these cells into dopaminergic neurons will allow us to study the functional outcome of these polymorphisms in the relevant cell context.

Project Mentor: Dr. Yu Luo, Department of Neurological Surgery

Experimental determination of sediment-water exchange a solute influenced by the burrowing bivalve, Mercenaria mercenaria.

Anna Duewiger, Environmental Geology

Bioturbation, the movement and reworking of sediments by plants and animals, has major effects on soft substrate marine and freshwater habitats. Benthic – sediment dwelling - organisms are responsible for most of the bioturbation of marine sediments because of their massive populations, diversity in species, and the vast amounts of soft substrate available for them to live in. The amount of bioturbation in a local environment can be used as an indicator for how healthy that environment is; healthy benthic communities cause more bioturbation. Mercenaria mercenaria, a common marine bivalve native to the eastern seaboard of the United Sates, are used as bioindicators for the amount of pollution and/or disturbance in a local environment. The purpose of this study is to establish baseline activity levels of mercenaria in different types of sediment without contamination so that future pollution abatement programs using mercenaria as bioindicators can compare the activities of mecenaria exposed to contaminants to a sediment specific baseline activity. This data is quantified as the rate of diffusion of a tracer in solution into the underlying sediment as a result of bioturbation. The organisms are expected to increase the diffusion rate of the solute into the sediment if their needs are met by the conditions in the sediment.

Project Mentor: Peter McCall, Department of Earth, Environment, and Planetary Sciences

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Hearing the Shape of the Universe: A Correlation Matrix Search for Oblique Torus Topologies

John Dulin, Physics

The past few years discerning the shape of the universe, particularly its topology or "connectedness", have focused on methods like cosmic crystallography and circles-in-the-sky searches to locate patterns in visible galaxy clusters or the cosmic microwave background (CMB) radiation, as well as examinations of the full CMB sky for telltale correlated patterns of intensity. While helping to constrain the universe's possible topologies,
these hunts have not discovered the ultimate universal shape.
This project aims to extend that investigation to a broader set of topological spaces, including some deformations of known spaces using the known correlation function
comparison method. These deformations include the oblique rectangular and hexagonal prisms, as well as their associated twisted spaces. As the correlation function comparison utilizes the full CMB sky, we build numerical tools to generate the CMB sky's correlation matrix, which quantifies the statistical correlation of the intensity of every pixel of CMB light data with that of every other. The ultimate goal of the generalization of these known methods to these tools and oblique prisms is to detect the unique discreteness of waves in a cosmologically non-trivial (topologically interesting) space.
To apply this idea to the three-dimensional space of the universe and its two-dimensional CMB,
we will be tiling the 3D universe at the time the CMB was produced with the
known standing wave solutions of radiation across the finite space of each candidate topology. ?From these models, we will then compare the observed CMB anisotropy with the
expected radiation emitted from our set of wave solutions for different candidate
shapes, with the goal of finding a single statistically significant correlation
between one of the possible topologies and the observed CMB.

Project Mentor: Glenn Starkman, Physics

BCL11a expression is upregulated in basal breast cancer and may be necessary for maintaining cancer stem cell properties

Garrett Dunlap, Biology

Breast cancer is a collection of diseases that can be divided into subtypes based on distinct gene expression signatures that are predictive of patient outcome. The claudin-low and basal subtypes, together referred to as triple-negative breast cancers (TNBC), have the poorest prognoses compared to all other subtypes. This is thought to be due to the higher percentage of tumor-initiating cells, or cancer stem cells (CSCs) within the tumors. CSCs are resistant to radiation and traditional chemotherapeutics, and no targeted treatment exists for TNBC. Thus, identifying factors required for CSC survival and proliferation is critical in order to develop new therapeutics. Previously, a zinc-finger transcription factor known as B-cell chronic lymphocytic leukemia/lymphoma 11a (BCL11a) was identified as highly expressed in TNBC compared with all other subtypes and critical for CSC fate in the breast. However, the mechanism by which BCL11a maintains the CSC population is unknown. We hypothesized that BCL11a is necessary to maintain CSC properties in the triple-negative breast cancer subtypes. Examination of a panel of breast cancer cell lines confirmed BCL11a upregulation in TNBC and revealed it preferentially elevated in cell lines representing the basal breast cancer. Transient BCL11a silencing in the basal cell line MDA-MB-468 resulted in a greater than 75% decrease in BCL11a expression that was sustained for more than 96 hours. Loss of BCL11a did not alter expression of candidate stem cell markers CD44, ALDH1A1, and CD133. However, the CSC markers specific to MDA-MB-468 cells have not been established. The functional impact of BCL11a silencing on the CSC properties of tumorsphere formation, proliferation and survival in basal breast cancer are ongoing. Combined, these data will assist in allowing us to elucidate the mechanism of action of BCL11a in triple-negative breast cancer.

Project Mentor: Dr. Ruth Keri, Department of Pharmacology

Effects of Qigong on Female Victims of IPV

Kaitlin Dunn, Nursing; **Lauren Starks**, Nursing

Intimate partner violence, also known as domestic violence, is a global issue that affects 10-50% of women worldwide (Garcia-Moreno et al., 2005). The burden of IPV on emotional, physical, and mental health is substantial and can lead to both short- and long-term negative health effects in victims of IPV. There is no exception for the presence of intimate partner violence (IPV) in Hong Kong. The problem of IPV is exacerbated by the cultural norms of the traditional Hong Kong: in a traditionally patriarchal culture, a woman is expected to be reserved, private, and obedient.

While the overall rates of reported crime and violence in Hong Kong are exceptionally low when compared to other communities and countries, these statistics do not always include IPV. IPV is frequently unreported especially to police and statistics related to IPV are not usually included in the full crime reports of the community. Therefore, it is important to assess the community first-hand to get an idea of the prevalence of IPV. Assessments made in Hong Kong through windshield surveys and interviews with community members have brought to light the existence of IPV in the Hong Kong community. Assessments have also revealed the lack of health care outlets and resources for abused women to utilize in Hong Kong.

Qigong is a meditative form of martial arts used for centuries in traditional Chinese medicine. The practice of qigong focuses on the opening of channels throughout the body to allow for appropriate flow of qi. In literature, qigong has been associated with reduced perceived stress levels, anxiety, and fatigue, and has enhanced quality of life and immune function in participants (Zeng et al., 2014 & Wang et al., 2014). It is hypothesized that a program incorporating qigong exercise for women who are victims of IPV will result in reduced psychological stress levels.

Project Mentor: Rita Sfiligoj, Nursing

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Co-Occurring Substance Use Disorders and Mental Illnesses in Incarcerated Populations and Effects on Recidivism: A Literature Review

Abigail Dwornik, Psychology

In this literature review, I look into how mental illness and substance use disorders affect incarcerated populations in the United States. By reviewing the literature, I gained an understanding of the prevalence of these disorders in jail and prison populations. I address whether or not these disorders appear to be correlated with an increased risk of reincarceration, and consider the current state of health care for these disorders is in prisons and jails. Finally, I discuss possible ways to reduce recidivism, or a return to prison or jail after a release, in populations with co-occurring disorders. Evidence shows that incarcerated people with co-occurring disorders are more likely to re-enter the prison system, and that the prison system is how many people with these disorders are receiving their health care. Better understanding the role that these disorders play and identifying ways in which incarcerated populations could be better treated could help lower incarceration and recidivism rates and improve the quality of care for many Americans.

Project Mentor: Sharon Milligan, Mandel School of Applied Social Sciences

Study on the Viability of Cells and the Effect Microtubules Have on Restoring Tight Junctions Between Cells

Jeff Eben, college prep

Tight junctions are intercellular complexes that prevent the movement of ions and small molecules between adjacent cells. Thus they are a critical component of protecting the lining of the intestinal tract from inflammation potentially caused by microbes in the gut lumen. Our preliminary data has shown that activated T cells modify the permeability of an intestinal epithelial cell monolayer. The goal of this study was to determine if microtubules are associated with this change in permeability. We grew Caco 2 cells as a monolayer on a permeable membrane and tested if depolymerizing microtubules or inhibiting the motor protein that carries cargo along the microtubules at different times before and after adding activated T would change the usual pattern of permeability. When an enigmatic black substance was found floating in the media and the electrical resistance of the monolayer was found to be extraordinarily high, we first did a smaller scale experiment using the calcium-chelator EDTA as a positive control to determine if the black substance was biological in nature and the source of the higher resistance, or if it were just some sort of gunk or dead cells which were clogging the membrane support and raising permeability. We found that when the monolayer was treated with EDTA, it behaved normally, displaying the expected large decrease in permeability. This lead us to assume that the cells were still biologically functioning and could be used for our planned experiment (with the caveat that the cells were not perfectly normal). When we used compounds that promoted tubulin depolymerization or inhibited the motor protein dynein alone and in the presence of activated T cells, we found that the disruption of microtubules and motor proteins actually increased electrical resistance for 24-48 hours before decreasing. This allowed us to conclude that microtubules played an unexpected complex regulatory role in tight junction maintenance.

Project Mentor: Alan Levine, Pharmacology

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Palaeothentid marsupials (Mammalia: Paucituberculata) from the middle Miocene locality of Quebrada Honda

Russell Engelman, Biology/Evolutionary Biology

Paucituberculatan marsupials, particularly members of the family Palaeothentidae, were an important part of South American mammal communities from the late Oligocene to the middle Miocene (30-12 million years ago). However, after the middle Miocene, paucituberculatans declined in diversity, eventually leaving only the few species still surviving today. Here, we describe new specimens of some of the youngest known palaeothentid marsupials from the late middle Miocene site of Quebrada Honda, Bolivia. These specimens include the first known lower dentitions of Acdestis maddeni as well as three new smaller species. The relatively high diversity of palaeothentids at Quebrada Honda combined with their wide distribution during the late middle Miocene and their abrupt disappearance thereafter suggests that the extinction of palaeothentid marsupials was relatively rapid.

Project Mentor: Darin Croft, Anatomy

A new species of small-bodied sparassodont (Mammalia, Metatheria) from the middle Miocene locality of Quebrada Honda, Bolivia

Russell Engelman, Biology/Evolutionary Biology

The Sparassodonta (Mammalia, Metatheria) are a group of carnivorous marsupial mammals that dominated the macropredatory guild of South America during the Cenozoic. Here, we describe a new species of sparassodont based on a single specimen from the middle Miocene locality of Quebrada Honda in southern Bolivia. This specimen clearly does not pertain to any previously known group of sparassodonts (e.g., Hathliacynidae, Borhyaenidae, etc.) and represents a morphotype previously unknown among the Sparassodonta. UF 27881 is distinguished from other sparassodonts by its short, broad rostrum and small size, among other features. However, we decline to coin a new name for UF 27881 due to the fragmentary nature of this specimen and the absence of most of its dentition. This specimen suggests that the appearance of carnivorous opossums later in the Cenozoic may represent an evolutionary response to the decline in small, predatory sparassodont taxa. This study documents new morphological diversity among the Sparassodonta and highlights the value of fossils from traditionally undersampled parts of South America.

Project Mentor: Darin Croft, Anatomy

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The role of GLI2 and GLI3 mutations in the structure and function of reproductive and urologic organs in female mice

Nicole Episalla, Biology; **Ali Fathollahi**, Biology

Introduction:Gli2 and Gli3 genes of the sonic hedgehog signaling pathway are transcriptional activators and repressors, respectively, that play a significant role in bladder and urethral differentiation, development, and function. It is known that a certain ratio in the expression and activity of Gli2 and Gli3 is necessary for normal development of urologic and non-urologic organs.
Objectives:To evaluate the phenotypic effects of Gli2 and Gli3 gene mutations on bladder and urethral development and function in a group of female mice.
Methods:Female CD1 mice (12-14 weeks) were bred to produce mutant genotypes. Mice were then divided into four groups: wild type (Gli2+/+; Gli3+/+); mutant Gli2 (li2+/-; Gli3+/+), mutant Gli3 (Gli2+/+; Gli3 d699/+), and mutant Gli 2 and 3 (Gli2+/-; Gli3d699/+), which were determined by Polymerase Chain Reaction. Histological studies, such as immunofluorescence staining and Protein Gene Product 9.5 staining, were performed on bladder and urethral sections. Functional studies including functional voiding studies, cystometrographic (CMG) studies, MRI, and leak point pressure (LPP) testing, were also performed.
Results:Female mutant Gli2+/-; Gli3d699/+ mice showed an enlarged clitoris, a reduction in distance between the clitoris and anal orifice, large vaginal orifices similar to cloaca, and inflammatory edema due to urinary infiltration around the vaginal orifice. Mutant mice also showed a small bladder size with transitional epithelial hyperplasia. Gli2+/-; Gli3d699/+ mice exhibited a wide urethra and a decrease in smooth muscle layer thickness in the urethral sphincter zone.The urethra also presented more mucosal folding, persistence of transitional epithelium, transitional epithelial hyperplasia, and degeneration and necrosis of epithelial cells.
Conclusion:This mouse model could serve as a valid representation of durable stress urinary incontinence and can be used for future therapeutic studies.

Project Mentor: Michael Kavran, Radiology

Calc-U-Stress: A Stress Measurement and Management System

Berit Eppard, Biomedical Engineering; **Wade Stewart**, Biomedical Engineering; **Namratha Reganti**, Biomedical Engineering

Calc-U-Stress is a system that receives real-time vital sign data from an electrode in order to calculate the stress level of an intubated cardiac patient coming out of sedation in the surgical intensive care unit. The system operates in conjunction with a Bodymedia electrode developed by Orbital Research which is placed on the patient's arm. The electrode collects an electrocardiogram and the galvanic skin response. This data is transmitted to a computer where our system receives the signal, feeds the vital sign data into our stress output algorithm, and generates an output display which shows the overall stress response of the patient over time.

This system is being designed for use in an International Review Board approved study in order to assess the effectiveness of a pre-existing post-surgery communication device in reducing patient stress. The communication device offers two buttons (yes/no) to a patient in order to respond to questions by the clinical staff without requiring speech. The Calc-U-Stress system allows the stress response of the patient to be tracked and will thus allow for a conclusion in regard to the effectiveness of the button system in reducing patient stress.

Project Mentor: Colin Drummond, Biomedical Engineering

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Agatha Hodgins and the Great War: How a Nurse Anesthetist Advanced Her Profession, Her Peers, and Western Civilization

Samuel Esterman, Political Science and Philosophy

PURPOSE: This paper examines the role of Agatha Hodgins in introducing anesthesiology to Europe and her role in advancing George Crile's dream of American scholars and scientists taking their rightful role as world leaders. More than this, Hodgins worked for the advancement of women in the medical field.
SIGNIFICANCE: In 1914, George Crile, a prominent surgeon in Cleveland, organized a hospital staff to assist in the war effort. He saw the war as an opportunity to advance medicine through experimental surgery, but he also saw it as a chance to break free of American political isolation and for the nation to take a leadership role in the world. Early on, he realized that he could not enact his revolution alone. Central to all of his plans was the head nurse anesthetist at Cleveland's Lakeside Hospital, Agatha Hodgins. She had joined Crile's private surgical service in 1908, suggesting that Crile had long since come to depend on her skills to make possible his surgical innovations. Now, in assembling a unit that would travel to France, Crile needed the best personnel possible and Hodgins was essential. Indeed, Hodgins, and her peers, were a significant factor in the medical advancements that distinguished World War I from previous wars. Even more so, Hodgins's efforts became the foundation for the lasting social revolution Crile dreamed of but was unable to secure on his own.
CONCLUSIONS: In seizing upon the war, as this paper argues, Hodgins recognized that she had the opportunity to enact social change by elevating the position of the nurse in the surgical theater and by improving the training of nurses. Her experience in the war led directly to her work to formalize the Lakeside Hospital School of Anesthetists and in founding the National Association of Nurse Anesthetists. In this way, Hodgins was a leader in the emerging second wave of American feminism illustrating how the Great War provided women with a chance to break free of Victorian values.

Project Mentor: Amy Absher, History/SAGES

Mechanistic Study of a Layered Liquid Crystal System in Consumer eWriter Devices; Quantitative Image Analytics

Justin Fada, Mechanical and Aerospace Engineering

Mechanistic studies of cholesteric liquid crystal displays in e-writer devices are of critical interest to Kent Displays Inc. To gain in-depth knowledge of the lifetime performance of materials comprising their devices we applied accelerated aging protocols to determine degradation modes and reliability of these devices. Devices are exposed to complex shipping routes and the effects from shipping along with other potential device environmental exposures need better understanding. The application of accelerated aging protocols will indicate a host of degradation modes in addition to those potentially activated during the shipping and handling of devices in an attempt to uncover both damage initiation processes and lifetime processes. Solar Durability and Lifetime Extension (SDLE) center studies employ colorimetry, spectroscopy, spectrophotometry, profilometry, surface resistance, nano-indentation, and optical scanning measurements to build a database of variable performance over time useful for correlating to stressors and damage. Optical scanning of the writable layer will be utilized with image processing and analysis performed in the "R" programming language towards the development of a robust image analysis package. Scripts will allow for systematic identification of characteristics present on the writable surface providing visual degradation and reliability insights of lifetime performance. These studies will yield greater device understanding for future design considerations.

Project Mentor: Roger H. French, Materials Science and Engineering

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Bio-Inspired Synthetic Soft GRIN Lenses

John Fergusson, College Prep

In light of controlling the propagation of electromagnetic waves through an optical medium, synthetic polymeric systems inspired by nature are currently being developed to enhance the performance of devices and/or living systems that utilize lenses. The lens in the human eye is different from classic lenses (e.g. camera lenses) in two ways: a) It is elastic and can change shape, b) The refractive index is not constant through the lens, but has a gradient refractive index (GRIN). In the classic lens, peripheral rays are over-focused, reducing field of view. In the GRIN lens, peripheral rays are focused to the same spot as other rays, resulting in a greater field of view. The soft elastomeric films used in this study are fabricated using nanolayer coextrusion technology. Each film contains more than 4000 nanolayers. These films become stacked upon one another until reaching 2 mm in thickness, and then consolidated into a single transparent sheet. Afterwards, each sheet becomes shaped into lenses by use of compression molding. Films compositions are varied during fabrication by volume ratios: 0 to 100% in steps of 10%. These compositions are evenly distributed throughout the consolidated sheet. The most prevalent properties measured are the refractive index [?n] mismatch between two polymers, and the overall % light-transmission of the multilayered structure. Current efforts are being made to improve the overall % light-transmission. Quantitative comparisons are made between the manner in which these films are stacked and consolidated. This involves the deployment of new procedures and changes made to existing experimental conditions. It is suspected that air is becoming trapped between films during stacking in an open environment, so films now are being mechanically rolled as opposed to the original laid film technique. Other considerations lead to investigating surface haze. It has been demonstrated that by adding an anti-reflective (AR) coating to current sheets, l

Project Mentor: Guoqiang Zhang, MSE

EMG Controlled Device for High Tetraplegic Patients

Michael Fishman, Biomedical Engineering; **Jacob Antunes**, Biomedical Engineering; **Allen VanMeter**, Biomedical Engineering

People with high tetraplegia have complete paralysis of limbs and torso, limiting their ability to interact with their environment and inhibiting their independence. The goal of this project is to develop an EMG-controlled device to give a greater sense of independence to individuals with high tetraplegia. Our selected design collects facial EMG signals off a patient to control mouse cursor movement on an Android smartphone screen. Our device is designed to be easily to setup by a nurse, intuitively be used by a patient, and give the greatest independence as to what the patient could control. The devised placement of surface electrodes and advanced circuitry development will allow us to acquire EMG signals from different locations independently and process an individual signal. Four EMG's will be acquired from the patient. The EMG's will be acquired using electrodes which are comfortably fixed to the patient's head by using a headband. Each EMG signal will be independently processed and analyzed. Based on user input, mouse cursor commands will be output to an Android smartphone. Our user will be able to control five different actions on a smartphone screen simultaneously. The EMG controlled cursor shows great promise for scaled up future studies and eventual clinical implementation.

Project Mentor: Colin Drummond, Biomedical Engineering

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Low-cost, Non-invasive Parkinson's Disease Tremor Suppression Device

Mary Clare Flaherty, Biomedical Engineering; **Barry Goldberg**, Biomedical Engineering; **Chiraag Lathia**, Biomedical Engineering

Parkinson's Disease (PD) is the second most prevalent neurodegenerative disease in the world for people over the age of 50. As the life expectancy of the world rises, so does the occurrence of Parksinson's Disease worldwide. One of the symptoms of PD is the existence of tremors, often found on the hand. Current tremor suppression treatments consist primarily of deep brain stimulation (DBS) - a costly and highly invasive surgery - or medication, which can cause negative side effects and lose efficacy over time. Neither solution is well-suited for a developing market, which cannot support high-cost treatment methods.

Our team aims to develop a low cost, non-invasive Parkinson's Disease tremor suppression device that can be marketed and produced in the developing world. Our device will be portable, lightweight, and straightforward to use for patients and clinicians. Furthermore, we aim to produce this device for under $100 in parts.

Our chosen method of tremor suppression is Trascranial Alternating Current Stimulations (tACS). This involves applying a stream of alternating current to the surface of a patient's head, counteracting the tremor. We do this by tracking and recording a patient's tremor using a hand-worn sensor, transforming and filtering this data using a laptop computer, and constructing a suitable waveform using a stimulator to produce the current. By applying the current wave out of phase with the patient's tremor, we will be able to counteract the tremor and reduce its amplitude.

Project Mentor: Colin Drummond, Biomedical Engineering

Extending the Dirac Equation: A New Tool for Finding Boundary Conditions

Joseph Flannery, Physics

A topological insulator is a material that behaves as an insulator in its interior but whose surface contains bound conducting states. The bulk of a topological insulator may be described by a massive Dirac model while the gapless surface states follow the massless Dirac equation. Currently lattice models are needed to give a unified description of the bulk and surface states [1]. In this project we will construct a unified description of the bulk and surface states working with a continuum Dirac description by imposing appropriate boundary conditions on the massive Dirac equation at the insulator surface. These boundary conditions must be consistent with the requirement that the Dirac Hamiltonian operator be hermitian and symmetries such as time-reversal and charge conjugation. The continuum description of topological insulators will be used to analyze insulators with nontrivial topologies and geometries. Electrons on the surface of cylindrical topological insulators have been shown to behave as though the cylinder is threaded by an Aharonov-Bohm flux [2]. In this project we will explore analogous effects on spheres and tori.

Project Mentor: Harsh Mathur, Physics

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Increasing Women's Sexual Health Knowledge and Overall Client Satisfaction at the Family Planning Clinic of St. Thomas, U.S. Virgin Islands

Melissa Fowler, BSN; **Katelyn Lupica**, BSN

In the U.S. Virgin Islands, sexually active adult women are generally underserved, uninsured, and lack the adequate knowledge regarding their sexual and reproductive health. The purpose of the project was to present women's sexual health lessons to family planning clients while they waited for their respective appointments over an eight week period. We partnered as public health educators with the Virgin Islands Department of Health Family Planning Clinic to establish weekly lessons that would increase clients' sexual health knowledge. The lessons taught ranged in topics from different forms of contraception made available by the clinic to the prevention and treatment of urinary tract and yeast infections. In addition to an increased knowledge in sexual health, a second goal of the project was to increase clients' overall satisfaction with their experience at the Family Planning Clinic. For every lesson, the ratio of client to health educator was approximately 7:1. At the end of each lesson, each client was given an evaluation form to fill out regarding the information given throughout the presentation as well as their satisfaction with the health educator. The evaluation consisted of closed and open-ended questions that served to gain necessary subjective feedback. Overall, the project served to promote greater health knowledge in a high need population on the island as well as establish the beginnings of sexual health promoting behaviors for the women of the Virgin Islands.

Project Mentor: Jesse Honsky MSN, MPH, RN, APHN-BC, Nursing

Carry That Weight: How do Tobacco Hornworm Moths (Manduca sexta) change flight behavior to compensate for increased body weight?

Jeremy Frank, Biology

Although animal flight may seem to be almost effortless, it is actually a highly complex behavior. To move through the air, flying animals must compensate for a variety of forces, such as aerodynamic drag and their own body weight. Insects, the first animals to evolve flight, have a wide variety of adaptations they can use to adapt their behavior to changes in these forces. These diverse adaptations have been studied for hundreds of years, but there are many aspects of them that we are only now able to consider. This is because new technologies, especially high-speed video cameras, have enabled us to measure elements of flight behavior that were previously impossible to observe. For example, it is well known that one of the major challenges of flight is in generating enough lift to overcome body weight, but the full range of mechanisms by which insects might accomplish this is not yet completely characterized. To begin to address this, we used high-speed videography to examine the flight of the Tobacco Hornworm Moth (Manduca sexta), a model organism for studies of insect flight. Moths, like almost all other insects, have two pairs of wings, and they are capable of moderating the flexibility of these wings by changing the degree to which the pairs connect to each other. Previous research from our lab has suggested that this linkage modulation may play a role in helping flying moths overcome their own body weight, with heavier moths linking their wings less, thus making them more flexible and able to produce more force. To further examine this possibility, we analyzed the degree to which flying moths linked their wings before and after we increased their weight with a magnetic load. This allowed us to examine how moths use their wing linkage modulation to deal with the challenge of increased body weight. The results of this study may have broad potential for increasing our understanding of insect flight, and will also have implications for man-made micro air vehicles.

Project Mentor: Mark Willis, Biology

Effect of Cowden Syndrome-Associated Germline SDHB-Q24R Mutation on PTEN Tumor Suppressive Function

Nicholas Fung, Biology

Cowden syndrome (CS) is a difficult-to-recognize autosomal dominant disorder characterized by a high lifetime risk of thyroid, breast and other cancers. Approximately 25% of CS can be attributed to a germline mutation in phosphatase and tensin homolog deleted on chromosome 10 (PTEN)—a tumor suppressor gene. Recently, succinate dehydrogenase (SDH) has also been identified as a CS predisposition gene, with variants co-occurring with PTEN mutations in ~7% of CS patients. Thus, it is important to study how SDH and PTEN interact. Previous work on this interaction in CS-associated thyroid cancer has shown that SDHB/D variants cause cellular respiratory dysfunction, resulting in the excessive generation of reactive oxygen species (ROS). High ROS levels can then act to alter the oxidative status and function of PTEN. Here, we investigated a novel SDH mutation (SDHB-Q24R) observed in a patient exhibiting a CS-like phenotype with papillary thyroid cancer. Because this mutation lies within the signal peptide of SDHB, we hypothesized that it may lead to SDH dysfunction due to incorrect translocation of SDHB through the mitochondrial membrane, subsequently affecting the oxidative status of PTEN. To address our hypothesis, we used patient-derived lymphoblastoid cells carrying SDHB-Q24R. We observed increased intracellular levels of ROS and lipid peroxidation—accompanied by resistance to ROS-induced apoptosis. Western blot revealed accumulation of nuclear oxidized PTEN and impaired PTEN function (elevated pAKT downstream of PTEN). Through co-immunoprecipitation, we then explored the mechanism by which oxidized PTEN affects normal PTEN function. Our data showed the presence of PTEN::Oxi-PTEN dimerization, indicating that oxidized PTEN may inhibit regular PTEN function in a dominant-negative fashion. In summary, our data suggest a novel mechanism whereby SDHB-Q24R germline mutation induces tumorigenesis mediated by nuclear PTEN accumulation and PTEN::Oxi-PTEN dimerization.

Project Mentor: Barbara Kuemerle, Biology

Investigation of the Effects of STAT1 Post-Translational Modification on the Interferon Signaling Responses

Anisha Garg, Biology

Post-translational modifications, such as phosphorylation, diversify protein function and increase cellular efficiency. Therefore, the modifications are critical to human survival. Without phosphorylation of the STAT1 protein during the interferon (IFN) signaling pathway in response to viral and bacterial infection, the immune response would be ineffective and incomplete. The phosphorylation of the tyrosine 701 and serine 727 sites of the STAT1 protein have been previously investigated and found to play a crucial role in the primary immune response, but not during the secondary response. Recently, a number of novel acetylation, methylation, and phosphorylation sites on the Stat1 protein have been identified including a novel serine 740 phosphorylation site. The goal of this research study was to investigate the role of serine 740 phosphorylation on the Stat1 protein in response to IFN-? treatment. A broad scope protein and gene expression analysis was performed using cells with wild type (WT) Stat1 and cells with Stat1 mutated at the serine 740 site with an alanine substitute (S740A) to remove phosphorylation capabilities. Lentiviral transduction was used to introduce WT and mutant S740A Stat1 constructs to establish new cell lines. Gene expression analysis via quantitative real time-polymerase chain reaction (qRT-PCR) and protein expression analysis using a western blot technique were used to characterize the response to IFN-? treatment. Loss of serine 740 phosphorylation was found to result in a gene dependent and IFN-? concentration specific effect on the expression of nine analyzed genes via qRT-PCR. Specifically, five of the nine genes that are known to play roles in the induction and execution of apoptosis were marginally down regulated due to the loss of phosphorylation. The expression of the remaining four genes and the proteins investigated via western blot analysis were not noticeably affected by the loss of serine 740 phosphorylation. Based on these observations, it can be concluded that the phosphorylation of serine 740 may play a minor role in apoptotic induction in response to IFN-?.

Project Mentor: Dr. Barbara Kuemerle, Biology

Characterizing Feulgen stained prostate pathology slides via computerized image analysis

Anna Gawlik, Biomedical Engineering

Approximately 240,000 people were diagnosed with and 30,000 people died from prostate cancer (CaP) in the United States in 2013. The current method for planning CaP treatment uses a grading system called the Gleason grade: a qualitative assessment of malignancy based on the morphology of cancer cells and pathological tumor stage. While Gleason grade has been established as a strong prognostic marker of disease outcome, it is subject to inter-observer variability and hence is not robust in predicting which patients undergoing radical prostatectomy are at risk for recurrence of CaP. New accurate and robust ways of identifying patients at high risk of recurrence after surgery would allow doctors to treat those patients with more aggressive radiation and chemotherapy, potentially reducing mortality. The focus of this project is on using computerized image analysis methods on Feulgen stained biopsy images to identify quantitative features associated with the DNA content of individual nuclei – DNA content having been shown to be associated with cancer presence and aggressiveness. Two segmentation algorithms, a modified region growing algorithm used by Monaco et al. and a watershed based segmentation method used by Veta et al., were tested on CaP images to detect individual nuclei. A pathologist annotation of 400 selected nuclei within a Feulgen stained image was used to establish "ground truth" for presence or absence of a nucleus. Using Monaco, the algorithm correctly identified 62.5% of the nuclei and 65.3% were false positives. With the Veta segmentation, 87% of the nuclei were identified and 68.2% were false positives. Both segmentations accurately identified a high percentage of the ground truth nuclei but also oversegmented the image and hence identified many incorrect nuclei. In future work, we will leverage our segmentations to extract and identify significant features and then pass them into a classifier to determine predictions of recurrence of prostate cancer.

Project Mentor: Dr. Anant Madabhushi, Biomedical Engineering

Characterizing TFEB Localization in Astrocytes and Microglia during Fibrillar and Soluble Amyloid Exposure.

Elanda Goduni, Psychology

Characterizing TFEB location in astrocytes and microglia during fibrilar and soluble amyloid exposure

Alzheimer's disease (AD) is a neurodegenerative disease that accounts for the vast majority of late-onset dementia [1]. AD is characterized by the presence of extracellular plaques composed of aggregated amyloid beta peptides (A?) [2]. There is evidence that a microglial deficit in clearance of misfolded A? is the main cause for the A? accumulation in AD mouse model. Microglia, the main phagocytic immune cells of the CNS, are involved in phagocytosis and degradation of misfolded A?. Importantly, microglia require properly acidified lysosomes to digest AB efficiently [4].

It has only recently been discovered that autophagy and lysosome biogenesis are regulated by transcription factor TFEB [7-10]. When TFEB is in the nucleus it induces transcription of itself, PPAR?, PGC1-?, and lysosomal genes including hydrolases, lysosomal membrane proteins, and the V-ATPase comple. Under normal circumstances, TFEB is phosphorylated by mTOR, which then interacts with 14-3-3, anchoring TFEB in the cytoplasm where it is functionally inactive. Upon cellular stress, especially the accumulation of aggregated proteins such as ?-synuclein or huntingtin, TFEB is dephosphorylated by PP2C and translocates to the nucleus, inducing autophagy and lysosome biosynthesi. Inhibition of mTOR with rapamycin results in translocation of TFEB to the nucleus and induction of autophagy, thus clearing ?-synuclein or htt aggregates, promoting neuronal survival, and improving behavior. It has also been reported that overexpression of TFEB results in clearance of ?-synuclein aggregates. The linkage of TFEB to AD is largely unexplored as there is only a single report that that mTOR inhibition elevates nuclear levels of TFEB and degradation of APP. Additionally, it has been shown that TFEB AAV overexpression driven by the GFAP promoter in the hippocampus resulted in reduced A? levels and plaque load locally.

Project Mentor: Gary Landreth, Neurosciences

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Studies Towards Slide Ring Gels

Daniel Gonzalez, College Prep

Slide ring gels are mechanically cross-linked polymers that are flexible, robust, and super-absorbing materials. The cross-links in this interesting class of materials consists of multiple polymer chains threaded through ring-like cyclic molecules and as such these macrocycles act as mobile crosslinks have the ability to slide along the polymer chains. The slide ring gels being targeted in this project are double-threaded rotaxanes and the synthetic approach to these systems is to use a metal ligand complexes to template the interlocked architecture. The end-groups of this structure are then capped with bulky molecules big enough to prevent the ring from dethreading. Removal the the metal ion template then yield the targeted slide ring gels. To create our rendition of the slide ring gel, we must construct macrocycle complexes, stopper groups, and threads. A significant component in assembling both macrocycles and threads is bis(benzimidazolyl)pyridine (Bip). Over the past several months, we have successfully synthesized both Bip-containing threads and macrocycles and shown that these materials can indeed be assembled in to gels.

Project Mentor: Katie Greenman, MSE

Proximal Localization of the Progesterone Receptor to the AP-1 Complex Subunits in Human Myometrial Cells

Hansaa Gopalakrishnan, Biology, Psychology

The progesterone receptor (PR) is a ligand activated transcription factor that affects the expression of specific target genes. The mechanism for PR-induced gene expression can be direct by binding to a progesterone response element (PRE), or indirect by modulating the activity of other transcription factors. PR transcriptional activity is important in the pregnancy uterus since PR-mediated progesterone action is vital for maintaining pregnancy. Progesterone promotes uterine quiescence via PR-mediated activity at a cohort of gene promoters that control contraction associated proteins (CAPs). The promoters of these genes, however, lack the PRE suggesting that PR functions by an indirect mechanism involving other factors. One of those is the AP-1 transcription factor complex, which has the cJun and Fos subunits.

We hypothesized that the PR isoforms, PR-A and PR-B, interact directly with the cJun and Fos subunits of the AP-1 complex to inhibit AP-1-induced expression of CAP genes. This predicts that PR will be in close proximity with AP-1 subunits and that this proximal localization will be affected by progesterone and the pro-labor agent interleukin-1ß (IL-1ß).

To test this hypothesis, proximity ligation assays (PLA) were performed in a human myometrial cell line. PLA uses secondary antibody probes that bind to primary antibodies from two different species. Each antibody has a short DNA strand that upon close proximity will interact and connect to form a circular DNA molecule, which can then be amplified and later quantified using DNA polymerase in the presence of a fluorescently labeled nucleotide.

We found that PR-B was in close proximity with the cJun subunit, interaction of PR-A with cJun was less than that of PR-B, and both were increased by ligand binding. IL-1ß decreased PR-cJun interaction. These data suggest that progesterone actions via the PRs is mediated in part by their interaction with AP-1 and that this effect is modulated by pro-labor stimuli.

Project Mentor: Sam Mesiano, Reproductive Biology and Ob-Gyn

Differential Scanning Calorimetry Analysis Identifying the Thermal Stability of Polymers to Determine Suitability as Biomedical Implant Materials

Aditi Gore, Biomedical Engineering; **Cloay Maier**, Biomedical Engineering; **Anita Venkataswamy**, Biomedical Engineering

In this study, several polymers were evaluated for their potential use as biomaterial implants according to their thermal properties determined by Differential Scanning Calorimetry (DSC). DSC measures properties such as melting temperature (Tm), crystallization temperatures (Tc), and the heat of fusion and crystallization. The glass transition temperature (Tg), oxidative induction time (OIT), and oxidation onset temperature are also determined by DSC. The polymers used in this experiment were obtained from the SPE ResinKit. Various polyolefin samples, with and without fillers, as well as Nylon 6-6, were run on the DSC. Ultimately, the polymers were ranked according to their thermal stability based on their relative OITs through DSC and their melting and crystallization rate peaks through first derivative analysis.

The experiment confirms PEEK as a paragon of quality and stability in medical plastics. According to the time-temperature superposition principle, higher decomposition temperatures correspond with longer polymer durability at room temperature. Our results demonstrate that PEEK has the highest relative OIT, which provides evidence of thermal stability. This is reaffirmed through the derivative analysis of PEEK, which shows sharper and narrower melting point peaks throughout its first derivative graph, indicating PEEK's controlled melting process and highly ordered, uniform structure. These properties suggest PEEK's greater success as an implantable material in biological conditions due to its predictable and stable behavior under extreme temperatures during DSC. Polycarbonate, which possesses similar but less pronounced features, is also deemed a viable candidate for use as an implant material. Low density polyethylene, however, has a noticeably lower OIT with a narrower and flatter melting peak due to its greater polydispersity and highly branched structure. This indicates that LDPE is likely an unsuitable material as a biomedical implant.

Project Mentor: Dr. Alan Riga, Macromolecular Science and Engineering (Polymer Science)

Agonistic Behaviors of Cuatro Ciénegas Cichlids and Texas Cichlids Due to Differences in Breeding Behaviors

Ryan Gorecki, Biology

Cuatro ciénegas cichlids, Hericthys minkleyi, and Texas cichlids, Herichthys cyanoguttatus, offer captivating displays of agnostic behaviors in both wild and captive environments. Previous studies on Herichthys spp. have suggested these species display similar agnostic behaviors which have developed to increase fitness levels. However, breeding and parental care of these two species differ dramatically from one another. H. minkleyi male cichlids are polygamous in which they defend multiple nests while female H. minkleyi cichlids remain at a single nest to defend, sometimes alone. In contrast, H. cyanoguttatus cichlids are monogamous and work together with their partner to defend their territory. While similar agnostic behaviors to defend these territories have been observed within the two species, the intensity of such behaviors has not been investigated. Such information could offer a greater understanding of how levels of aggression are determined within species as well as offer future predictability of aggression levels of other cichlid species with similar breeding behaviors. Thus, this research seeks to determine if either breeding or parental care behavior influences a greater intensity of agonistic displays by quantifying the duration and number of times an agonistic behavior is displayed by an individual specimen toward a stimulus. From preliminary analysis of the two species, H. minkleyi cichlids have displayed more activity toward stimulus fish, suggesting a potential for higher levels of aggression.

Project Mentor: Roy Ritzmann, Biology

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Evidence of Butchery and Predation on the Cedar Creek Mastodon

Robert Hannan, Anthropology with a concentration in Archaeology

Remains of Pleistocene proboscideans in Ohio typically are nearly complete skeletons or represented by only one or two bones and teeth. Investigation of the Cedar Creek Mastodon found near a bog in Morrow County, Ohio indicates that this individual may be a midpoint between these two extremes of preservation. Laboratory evaluation includes analysis and measurement of the remains and markings, interpretation of the various marks according to existing literature, and determination of the probable origins of these marks as to their relationship with human and animal predation. In addition to the mastodon remains, the excavation recovered two flint flakes, possibly representative of butchering tools, though the stratigraphy of the site makes the association between these and the skeletal remains difficult to establish conclusively. Thus far, the remains have not been successfully carbon dated due to severe collagen deterioration. The combination of sheer variety and number of markings, the degradation of the remains, and the stratigraphy of the site points to the importance of this individual as having experienced a different pattern of death and preservation than that of other mastodons previously found in Ohio.

Project Mentor: Dr. Brian Redmond, Anthropology

Characterizing the endocardial cell shape and structure of fetal avian hearts by utilizing whole mount immunofluorescence staining

Arvind Haran, Systems Biology

Abnormal heart development in the embryonic stage of growth can lead to congenital heart defects (CHDs) that can cause lifelong heart disease. Previous studies show that early changes in cardiac function, such as arrhythmic contractions or abnormal blood flow, can alter the endocardial and myocardial cell shape and structure. These cell structural changes can cause further functional abnormalities, creating a vicious feedback loop that may lead to deformities such as valve defects and great vessel anomalies. Thus, developing a method for visualizing cell shape and structure changes in the heart is necessary for understanding the mechanisms of how CHDs form and is therefore the purpose of this project. To view the shape of endocardial cells in a quail embryonic heart, indirect immunofluorescence staining was used. This technique is typically used on sections of tissue, but sectioning only provides 2D images of cell shape and may distort 3D reconstructions of a group of slices. Hence, whole mount staining was used to preserve the cell shapes. Stage 15 quail embryo hearts were dissected and stained with QH-1 primary antibody and AlexaFluor488 labeled goat antimouse IgG second antibody to view the cell membranes of the endocardium. The hearts were then imaged using confocal microscopy and the images were analyzed in FIJI. The protocol we developed led to bright endocardial cell membrane staining at the ends of the heart tube but diminished when in the middle of the tube. We were able to visualize the 3D shape of a portion of endocardium, but the confocal microscope could not image the sample deeply enough to see the entire tissue. Thus, more even staining throughout the heart and a more robust imaging technique must be pursued in future work. When these methods are perfected, we will contrast the endocardial cell shape of control hearts from hearts with induced functional abnormalities. This will provide information towards understanding the mechanisms of how CHDs form.

Project Mentor: Michael Jenkins, Pediatrics

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Increasing High School Student's Awareness of Diabetes and its Effects on Patient Care

Nicole Harioka, Nursing; **Carol Kim**, Nursing; **Faith Fulgaro**, Nursing

Renal failure related to diabetes complications is one of the major causes of death in Hawaii. Upon close examination, the statistics show that the population of Waianae has a higher rate of diabetes than the rest of the island of Oahu due to their socioeconomic disadvantage and ethnic risk factors. Therefore, our Capstone project was designed to impact the community by teaching high school students interested in finding a career in the medical field about diabetes and how it affects patient care. Our intervention included diabetes specific lectures covering various topics such as risk factors, signs and symptoms, and complications of diabetes. The laboratory segment of our lectures highlighted how diabetes affects patient care, and the precautions that healthcare workers take to prevent further complications in their patients with diabetes. Results of the project were statistically calculated based upon the pre and post-test surveys that were administered before and after the intervention. In conclusion, the goal of the intervention was to continually promote health and wellness in the community through educating the youth about diabetes. It is hoped that the knowledge would be passed on to their family members and eventually impact the entire community.

Project Mentor: Dr. Patricia McDonald, Nursing

Multifunctional and Spatially Controlled Bioconjugation to Melt Coextruded Poly(e-caprolactone) Fibers

Emily Harker, Polymer Science and Engineering

Synthetic polymeric fibers are attractive for use in various biomedical applications such as regenerative medicine, drug delivery and wound-healing patches. Controllable porosity of the polymer scaffold allows for the influx of nutrients and the removal of waste, as well as cell infiltration. In addition, coextrusion has developed as a method to produce biocompatible fibers on a microscale to submicron scale [1]. Using the multilayer coextrusion method, the aligned poly(e-caprolactone) (PCL) fibers were produced without additional orientation. For regenerative medicine, it is important for the scaffold to mimic the extracellular matrix to promote tissue regeneration. The coextrusion fibers are good candidates for the production of scaffolds that will mimic the natural extracellular matrix by acting as a support for tissue growth, as well as the ability to be functionalized with cell responsive peptides or various growth factors via bioconjugation. In order to decorate bioactive cues onto the surface of PCL fibers, funtionalized photosensitive linkers (propargyl benzophenone, prophenyl benzophenone and aminooxy benzophenone) were used as the moieties to click bioactive cues. The modification method of photosensitive linkers onto the surface PCL fibers was able to control the density of the functional groups with UV irradiation time. The optimal amount of peptides or growth factors can then be conjugated to the surface by controlling the quantity of photosensitive linkers on the surface of the PCL fibers. Various chemistries, copper azide alkyne cycloaddition (CuAAC), Thiol-ene reaction and Oxime chemistry, were performed as click tools for bioconjugation. Finally, the introduction of biofuntionalities on PCL fibers by various chemical bioconjugations allowed for providing enhancement of cell adhesion, differentiation and growth.

Project Mentor: Jon Pokorski, Macromolecular Science and Engineering

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Search for Quark Gluon Plasma

Jonathan Harper, Math and Physics

Quark-gluon plasma (QGP) is a proposed state of matter in which baryons and mesons separate into a collection of free particles. The high energy requirements needed for QGP to form make it difficult to create or detect. As a result we search for evidence of QGP in cosmic ray showers by utilizing the computer program CORSIKA to simulate particle shower data. Accurate shower simulations where QGP may form require precise input parameters and must be performed at high energy. Since the number of interactions and resulting particles scales with the energy of the shower, simulations where QGP may form are difficult, time consumning and computationally onerous to perform.

For this project we will investigate the nature of QGP and attempt to address some of the underlying complications associated with its detection in CORSIKA simulations. First, the height of first interaction, an important input parmeter for accurate simulations, will be calculated for several high energy showers of varying types. Secondly, for showers of high energy, a method of thinning the shower is often applied. This algorithm reduces the computational complexity of a shower by combining many lower energy particles into a single particle of a higher energy. While this can drastically reduce run time it comes at the cost of accurate particle data. This project will attempt to understand the effects of a potential "unthinning" procedure which may increase the quality of detected particle data when thinning is applied. If successful, thinning will make it more possible to simulate the high energy showers resulting from QGP collisions, making it easier to identify such showers in experimental data.

Project Mentor: Corbin Covault, Physics

Bicycling and Health Outcomes in Denmark and the U.S.

Renee Hartney, Nursing; **Merilee Avery**, Nursing; **Mariah Wilson**, Nursing

Biking as a form of commuting has many benefits affecting individuals and the community, but it also poses the potential for some risks. Copenhagen is a major biking city and therefore has a large percentage of its population involved in this matter. This study summarizes three papers written about health risks involved with biking including bone mineral density, air pollution, and traumatic brain injury. It also assesses the benefits, risks, and ways in which safe biking can be achieved in the United States and Denmark. Beneficial health impacts from cycling can affect the individual as well as society as a whole. An active lifestyle can decrease the risk of acquired diseases such as heart disease and obesity. Using cycling as the main form of transportation reduces overall CO_2 emissions, benefiting the environment and the community. Risks involved are related to safety in traffic and possible long term effects on bone and lung health. To fully take advantage of all the benefits involved with cycling, some precautions can be taken and are reviewed.

Project Mentor: Jesse Honsky, Nursing

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Effects of Solar Ultraviolet Radiation on Melanocytes

Jonathan Hess, Biochemistry

In 2014, about 76,000 people were affected by melanoma skin cancer and the rates have been steadily increasing each year. This project focuses on the role of solar ultraviolet radiation in the development of a melanoma. The primary concern for this experiment is the study of exosomes and their role in the metastasis process. Exosomes are a class of membrane bound organelles that pinch off of cells and travel to surrounding cells. Exosomes are currently believed to be a primary messenger in the metastasis process of skin cancer. The project is divided into two main experiments: First, the culturing of melanocyte cells including the irradiation of melanocytes using increasing ultraviolet intensities. Second, the harvesting of the exosomes and subsequent protein analysis through Western Blot analysis and Silver Stain analysis. This project expects to find evident differences between the contents of the irradiated and un-irradiated exosomes that could provide insight into important melanoma protein markers. The results and conclusions will be discussed.

Project Mentor: Dr. Marian Harter, Biochemistry and The Case Comprehensive Cancer Center

Mechanical properties and performance of hand tools fabricated by additive manufacturing

Jeremy Hirschler, Chemical Engineering

Additive manufacturing, otherwise known as "3D printing", is an alternative way to fabricate parts which would normally be manufactured by other production methods, and is seeing a rise in usage within recent years. There are various benefits to additive manufacturing, including being more cost efficient, shorter lead times, and flexibility to customize a part. In order to make 3D parts, a three dimensional model needs to be made using Computer Aided Design (CAD) software. Once the model is completed, it needs to be converted into a STL file, then transferred to the additive manufacturing machine that can read this new type of file. After the printer is set up properly, with information such as layer thickness, the part can then be built. Here, we wanted to examine if we could make 3D printed hand tools. Hand tools have a variety of functional applications, which is why it is important that these tools behave as intended. Certain materials like stainless steel and chromium-vanadium steel alloys may be used for a part since these metals do not easily corrode. In terms of being ergonomic, some wrenches, for example, can be manufactured to include an adjustable handle length for different applications and users. Additive manufacturing allows for these requirements to be met since a part can be customized to a wide range of shapes and raw materials. The maraging steel we used to make the 3D printed parts is a much stronger alloy than the steel used in the forgings. The mechanical properties of the Maraging 250 alloy were tested. The stress at fracture was 175ksi and the ductility was 14%. These 3D printed parts are expected to outperform the forged counterparts. The cost of each 3D printed part is about $2,000. This is a high price. However, the tooling required to forge the parts costs upward of $40,000. This means for a small number of parts 3D printing could be competitive. However, when large quantities of parts are needed, forging would be a lower-cost alternative.

Project Mentor: David Schwam, Materials Science and Engineering

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Swim patterns of the pig-nosed turtle compared to other freshwater turtles

Stephano Hong, Biology

Freshwater and sea turtles exhibit different swim patterns due to the differences in their limb structures. Freshwater turtles use webbed claws to walk on land as well as swim, and use the rowing swim pattern. Sea turtles, however, stay in the water for most of their lives, so they have flippers that are not very useful on land. They use a swim pattern called.
Rowing is achieved using all four limbs to create a thrust-generating powerstroke at a high-drag angle, followed by a recovery stroke at a low-drag angle. Contrarily, flapping uses lift-based mechanisms that generate forward thrust through movement at an intermediate-drag angle without a definitive recovery stroke. Of the two, rowing is more maneuverable and flapping is more energy efficient, making them naturally suited for freshwater turtles and sea turtles, respectively.
The pig-nosed turtle (Carettochelys insculpta) is a freshwater turtle that spends most of its life in the water. As a result, the pig-nosed turtle has flippers similar to a sea turtle. To determine if its unique limb design translates into a different swim pattern, the pig nosed turtle and other freshwater turtles will be captured on high-speed video and analyzed with motion analysis software to determine their similarities and differences.

Project Mentor: Roy Ritzmann, Biology

Modeling Magnetic Resonance Fingerprinting Signals in the Presence of Exchange

Stephanie Hougen, Physics

The use of magnetic resonance imaging (MRI) has become increasingly common in today's medical system, as almost every hospital has at least one machine. The increased demand for commercial use of MRI leads to an increase in the research behind the machine. Researchers are constantly working to improve the machines accuracy, efficiency, and cost effectiveness.

This research is aimed at increasing the accuracy of the MRI machine to allow doctors superior diagnostic information. It is widely assumed that when scanning two different kinds of tissues, for instance myelin and fat, the tissues are completely separate, and have no interaction or effect on one another's magnetizations. This notion is suspected to be incorrect as the protons from the fat cells, exchange with the protons from the myelin cells, a process that can lead to a significantly altered signal.

If the effect of the exchange is not accounted for, the information given to the radiologists can be incorrect or misleading. This project aims to eradicate these discrepancies by creating an analytical model that accounts for the effects of exchange. This concept will be first applied to a more traditional form of MRI, and then expanded to included the new analytical model, magnetic resonance fingerprinting.

Project Mentor: Mark Griswold, Radiology

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Quantitative molecular magnetic resonance imaging of glioma tumors with a PTPμ targeted contrast agent

Michael Howell, Mathematics + Education

The goal of this project was to test the effectiveness of a novel contrast agent that specifically detects tumors the brain tumor glioblastoma multiforme (GBM) in magnetic resonance imaging. GBM is the most common and aggressive malignant brain tumor in adults. Although rare, it is deadly and results in patient death in 5 months if not treated and 15 months with treatment. GBM cells are widely infiltrative throughout the brain at diagnosis making a complete resection difficult. In order for surgeons to resect more of the tumor, new technology is required to recognize tumor cells. MRI is the preferred method of tumor imaging before surgery, however it is limited to showing anatomy and gross pathology. In GBM, MRI cannot separate the complex and irregular shapes of tumors from edema, gliosis, and necrosis. To improve specificity, molecular MRI technology has been developed to label proteins in the tumor microenvironment using probes that are conjugated to contrast-generating metals such as gadolinium. PTPmu, a receptor protein tyrosine phosphatase, is an example of a protein that is proteolyzed in the tumor microenvironment. Previous studies have validated extracellular fragments of PTPmu as viable targets in models of GBM using a peptide probe, SBK2. This probe was able to detect dispersing tumor cells millimeters from the main tumor mass. Furthermore, the SBK2 peptide conjugated to a gadolinium chelate [SBK2-Tris-(Gd-DOTA)3] was validated as an MRI-detectable molecular probe. In this study, we compared the tumor recognition of that agent to the generic clinical contrast agent OptiMark using a quantitative T1 mapping technique by MRI. The two agents were compared based on the extent and duration that they enhanced tumors in MRI. Once the images were obtained, MATLAB programs were developed to quantitatively compare the effectiveness of the two agents. The results of this study demonstrated increased effectiveness of the PTPmu agent in identifying GBM tumors.

Project Mentor: Susann Brady-Kalnay, Molecular Biology & Microbiology

Exploring anthropogenic influences on environment and infectious disease emergence

Una Huang, Anthropology

The emergence and re-emergence of infectious disease has been an increasing concern in public health in the past few decades. This poster explores the existing literature on the emergence of infectious disease; specifically focusing on the role of anthropogenic factors in disease emergence. The impact of anthropogenically caused habitat alteration and decreased biodiversity are highlighted as well as the process of disease "spillover" and "spillback" in which pathogens move from wildlife to domestic animals to humans, resulting in the introduction of these diseases into new geographic locations. Examples of this process of "pathogen pollution" (Daszak et al 2001) include increased numbers of cases of Lyme disease in the Northeastern United States as suburban regions expand into more wooded areas. Around the world, the emergence of novel diseases in humans such as Hantavirus, Nipahvirus, and SARS (and more recently, the re-emergence of Ebola) have been noted in the last 20-30 years. Some factors behind these and other disease emergences can be attributed to farming practices with domesticated animals and agriculture, farm or settlement growth and subsequent encroachment into wildlife habitats which alter animal reservoirs' living patterns, and increased human movement around the world for travel (ecotourism) or migration, all of which can increase human exposure to zoonotic illnesses. As the global human population increases and other anthropogenically related factors continue to affect ecosystems and wildlife interactions around the world, more emerging infectious diseases are to be expected—continued attention to the relationship between humans, environment, and disease can aid in public health surveillance and anticipate patterns in disease emergence.

Project Mentor: Janet McGrath, Anthropology

Global Analysis of Nonsense-Mediated mRNA Decay Provides Evidence for Translation of lncRNAs

Nathan Huynh, Biochemistry

Nonsense-mediated mRNA decay (NMD) is a cellular quality control mechanism that monitors mRNA for the presence of nonsense or premature stop codons. In order to identify targets of NMD in the cell, gene expression profiling was conducted in yeast cells with and without a functional NMD pathway using high-throughput DNA sequencing. Sequencing data indicated that approximately 600 mRNAs showed greater than two-fold expression level changes in the absence of NMD. Unexpectedly, approximately 200 long non-coding RNAs (lncRNAs) also expressed sensitivity to NMD, which functions as a translation-dependent RNA surveillance process.

Putative mRNA and lncRNA targets of the NMD pathway identified by deep sequencing were verified by Northern analysis. Standard radiolabeled oligonucleotide probes were used to detect individual RNA in wild-type cells and cells lacking the essential NMD component, UPF1. In order to detect low abundant mRNAs, radiolabeled probes generated by asymmetric PCR were employed. Through this approach, several putative targets were validated as NMD-sensitive, including a number of predicted lncRNAs. These findings indicate that a subset of lncRNAs are translated and targeted to NMD despite being predicted to lack protein-coding capacity.

We used reverse genetics to determine a possible role for lncRNAs predicted by our studies to express polypeptides in yeast cells. We deleted the genes expressing a number of individual lncRNAs and tested these yeast strains for phenotypic responses through exposure to various chemical and environmental conditions compared to wild-type cells. 30 different growth conditions were tested, determining that yeast strains lacking four independent lncRNA genes displayed differential sensitivity to growth in the presence of hydrogen peroxide or cycloheximide. These results suggest at biological roles for these lncRNAs, providing a basis for further experiments towards understanding the roles of these lncRNA genes in the cell.

Project Mentor: Kristian Baker, Center for RNA Molecular Biology

Dynamics of bird flight take off patterns in tail and wings

Nathanaelle Ibeziako, Biology; **Phillip Akanbi**, Biology/Psychology

In the development of aviation technologies, several aspects of bird flight patterns and bodily orientations have been analyzed. These usually include the general positions of the wings and tail. One aspect of flight aerodynamics has been compared to the mechanics of delta-wing-theory for airplanes. While this notion has been extensively explored in the literature of bird flight the importance of wing assistance has been greatly undermined in the literature. In this research, we look specifically at flight take-off noting the wing flap speed, take off angle, and the change tail to body angle. These aspects of take-off flight dynamics is compared within a wide range of bird sizes and take off elevations. We find that the tail's angle of curvature does have a significant impact on wing beat speed that is more pronounced in larger birds. This impact may correlate with decreased wing load and higher maneuverability during take-off. Preliminary data suggests that a higher wing flap speed correlates to birds of smaller size suggesting that birds of a smaller mass require less force to elevate their bodies. Also the wing flap speed gives information on the bird's lift to drag ratio, which states that birds with a larger ratio generally have larger wings. The larger ratio is accompanied by the lower wing flap frequency along with an increase in gliding flight. In the case of smaller birds, because their wings are inherently smaller, they have a smaller ratio, decreasing gliding flight and increasing wing flap frequency. This higher frequency correlates to a higher wing flap speed. Our research will provide a greater understanding of bird wings and tails and the way they are used by different criteria of birds to generate patterns of flight.

Project Mentor: Roy Ritzmann, Biology

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Changes in Blood Serum Cation Content in Soy Diet & Mg+2 and its Effect on Cell Cycle.

Saagar Jagetia, College Prep

Dietary Soy is highly used for its nutrients and as a source of amino acids in Asian vegetarian and vegan diets. In this study we tested the affect of soy administration on liver cell cation content in obese male Zucker rats. These rats were divided into four experimental groups: Lean on casein (LC); lean on soy (LS); obese on casein (OC); and obese on soy (OS).
From data collected, we established that the OS had the highest protein content followed by the LS, the OC and finally the LC. In terms of cations, LC and OC groups had the highest potassium content with no significant different between the two, and the two soy groups had lower potassium levels also with no significant difference. When the sodium content was observed, the two obese groups had more sodium, with the OS being the highest. No significant differences were found between the two lean groups. The calcium content had the same distribution among groups as the sodium. There were no significant differences in Magnesium content among the groups.
Our results suggest that soy administration results in increased sodium and calcium content within the samples. This increase in calcium and sodium could reflect the increased protein content as well. Further studies need to be done to clarify the mechanisms responsible for this cation distribution.

Project Mentor: Dr. Andrea Romani, Physiology and Biophysics

The Effects of Domestic Violence Education in Nicaragua

Eileen Johnson, Nursing; **Kathleen Broderick**, Nursing; **Lena McCoy**, Nursing

Domestic violence is a significant issue in Nicaragua. In fact, one in three women will be a victim of domestic violence, and 34 percent of the crimes committed in 2013 involved domestic violence. Domestic violence is prevalent in the country because of its proximity to four of the top five countries in the world with the highest homicide rates, and because of its socioeconomic conditions, many of which correlate with the domestic violence risk factors published by the Center for Disease Control and Prevention (CDC). The lack of acknowledgment, knowledge, and open communication about domestic violence also contribute to the existence of violence. The nursing students decided to implement an education program, "Day of Nonviolence," in Spanish to teach adolescents and adults about the types of violence, resources for victims to get help, and signs and risk factors of domestic violence. A diagnostic test was administered before and after education to evaluate progress. The ultimate goal was to decrease the occurrence of domestic violence in Viejo Norte, and the goal of the study was to increase domestic violence knowledge for 30 percent of the program attendees by at least 1 point on a13 point scale. The test and education was developed from information gathered from data and culturally specific information gathered from three meetings held with authority figures in the community such as the police and Community Leaders. Definitions of domestic violence were created that conformed to the prevalent cultural views. The education program proved to be effective, as 45 percent of the attendees improved their score by at least 1 point. Score improvements were shown regardless of prior knowledge or sex, so the lesson was presented in a generally effective fashion which could be learned, retained, and accepted by the general population.

Project Mentor: Lynn Lotas, Nursing

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Internalized Racism as an Independent Risk Factor for Violence in African American Male Youth

Elizabeth Jordan, Psychology

Internalized racism is defined as the acceptance by members of a stigmatized race of the negative messages about their abilities and intrinsic worth. The term can also be defined as the acceptance of hegemonic hierarchical stratifications of race that places a member of a particular race at the bottom of the hierarchy, causing one to shame their racial identity. Research indicates that internalized racism may play a causal role in youth violent behavior. This research examines why internalized racism becomes an independent risk factor for violence in African American male youths above and beyond the structural issues of society, and proposes an intervention to minimize the effects of internalized racism. The intervention is based on narrative therapy. Such approach holds that identity is shaped by narratives or stories, whether uniquely personal or culturally general. Identity conclusions and performances that are problematic for individuals or groups signify the dominance of a problem-saturated story. Narrative therapy helps determine ways of understanding problems and their effects on people's lives. In the case of internalized racism, narrative therapy may help African American youth males realize the importance of their cultural identity, their self-worth, and of engaging in non-violent behavior.

Project Mentor: Dr. Lee Thompson, Psychological Sciences

Chia Seed Exudate Used for Separation of Oil and Water

Nathaniel Jurcago, Macromolecular Engineering

Naturally occurring hydrogel was extracted from Chia seed and was used to coat stainless steel mesh. Wire mesh is coated with the hydrogel and expected to let water pass through while retaining any oil substance. This is done by testing the contact angles of different oils and alcohols on the coated mesh. The ability to strain water and retain oil will be tested by sealing oil onto the mesh so that it does not roll off and then pouring water onto that mesh to let gravity strain the water through the mesh. Relevant and prominent uses are to be a cheaper and more easily produced alternative to other oleophilic coatings. Scanning electron microscopy, FT-IR spectroscopy, and X-ray photoelectron spectroscopy were used to characterize the coating and measure the separation performance.

Project Mentor: Al de Leon, Polymers

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Controlled Induction of Plasmodium falciparum Gametocytes for Detection

Ananya Kalahasti, College Prep

The Plasmodium falciparum (Pf) parasite is transmitted between people by the female Anopheles mosquito, which feeds on an infected person's blood, taking up the sexual gametocyte stage of the malaria parasites. These stages mate and replicate within the mosquito, passing on to another person at her next feed. Previous methods have not generated large volumes of synchronized sexual stages, impeding research. The goal of the project was to create a reproducible method of generating large numbers of gametocytes, the essential stage for continued person-person transmission, to further laboratory studies. Conditioned media (CM) was created by culturing Pf laboratory strain 3D7 in standard Continuous Malaria Culture Media for 5 days, after which the media was collected and aliquoted for use to stimulate asexual parasites to commit to sexual stage development. New 3D7 parasites were thawed and synchronized to the trophozoite stage, the mid stage of asexual development. The highly synchronized culture was divided into four conditions at a 1.2% parasitemia and a 3% hematocrit. Each condition was treated with a different concentration of CM (0%, 10%, 20%, 30%), and each was run in triplicate. After 36 hours of exposure to CM, fresh media was applied daily to the culture for 5 days, and maintained at 37ºC in 5% O_2, 5% CO_2, and N_2 balance gassed box inside a 5% CO_2 incubator. Giemsa stained slides were made daily and counted using microscopy. Data showed that wells exposed to higher concentrations of CM showed an increase in gametocytemia (10% CM=13.3% ±1.5, 20% CM=15% ±3.0, 30% CM=27.3% ±3.5), compared to the control (0% CM=5.7% ±3.9). The experiment showed a reliable and quick method for producing gametocytes in large quantities for research. Future experiments will examine varying exposure times to CM, and parasite sensitivity at different hours post-invasion. The ultimate goal of the project is to use this method to test early detection devices currently under development.

Project Mentor: Dr. Brian Grimberg, Center for Global Health and Diseases

Hand Sanitation Practice on Healthcare Associated Infection (HAI) Rate in Veterans Affair Hospital

Shriya Kannan, BME; **Lauren Phillips**, BME; **Srikanth Gowda**, BME

Healthcare associated infections (HAIs) are infections that are developed usually in hospitals when a patient receives a healthcare treatment. HAIs are caused by a variety of common and unusual bacteria, fungi, and viruses. They cause significant morbidity and mortality in patients and lead to longer stays in the hospitals, which lead to a number of issues including increased insurance costs. Approximately 1 in every 25 patients have at least one HAI during their stay at a hospitals, with more than 722,000 HAIs reported annually in the US alone, leading to billions of dollars in costs and detrimental effects to patient health. Therefore, there is a great need for a systematic approach to combating HAIs. Advances have already been made in spreading awareness and incorporating procedures for doctors, nurses, and other hospital staff to sanitize their hands to reduce the rate of HAIs, but HAIs can also come from the patients themselves. Therefore there is great opportunity to potentially reduce the rate of HAIs by encouraging patient hand sanitization. Current options available to patients, such as bathroom sinks, hand wipes, and wall-mounted hand sanitizer dispensers, are typically located far away from the patient bed, making it difficult for patients with limited mobility to use. Also, these options do not remind patients to sanitize their hands, leaving room for improvement. Therefore our group is developing a motion, hand-sanitizer dispenser that mounts to the patient bed, provides visual and audio reminders to patients, and counts the number of uses to track patient compliance.

Project Mentor: Colin Drummond, BME

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Correlating kinetics and kinematics of earthworm peristaltic locomotion

Elishama Kanu, Chemical Biology/Cognitive Science

The study of biological organisms may aid with designing more dynamic, adaptable robots. In this paper, we quantitatively studied the coupling of kinematics and kinetics in the common earthworm, Lumbricus terrestris. Our data correlates changes in worm segment shape to variable, non-uniform load distribution of worm weight. This presumably leads to variable friction forces. Understanding the way the worm exerts these forces may help us implement peristalsis on robots in diverse real-world environments. In our preliminary data, at the front of the worm, the segments with the widest diameter bear the most weight and anchor the worm to the ground during motion, as we hypothesized. The rear segments also exhibit variation in ground reaction forces. However, for rear segments, the peak kinetic waves are phase-shifted from the kinematic waves. Future work will explore this phenomenon.

Project Mentor: Hillel Chiel, Biology

A Critical Summary of Research on ADHD Treatment Strategies from the Last Decade

Matthew Karpinski, Cognitive Science

Attention Deficit Hyperactivity Disorder (ADHD) is a cognitive disorder that affects a child's ability to attend to stimuli and control various impulses. Research in treating children with ADHD has expanded greatly over the last decade, and treatment strategies now generally use a combination of drug medication (atomoxetine, methylphenidate, lisdexamfetamine, and/or amphetamine) and behavioral therapy. In this review, the most widely cited studies investigating overall efficacies of ADHD treatments are summarized and evaluated. It's concluded that drug medication is recommended to successfully treat ADHD and any other behavioral therapy serves best as an adjunct treatment approach. Ultimately, more research needs to be done evaluating the severity of side effects for the various medications and how efficacious they are when presented a comorbid diagnosis.

Project Mentor: Vera Tobin, Cognitive Science

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Point of Care Pediatric Respiratory Virus Panel

Daniel Kernan, Biomedical Engineering; **Sophia Colevas**, Biomedical Engineering; **Andrew Kilroy**, Biomedical Engineering

The goal of the Point of Care Pediatric Respiratory Virus Panel is to create a user friendly, at home diagnostic testing kit. This panel will test for 8 of the most common respiratory viruses among the pediatric population, including RSV, Influenza A, Influenza B, rhinovirus, and others. The focus of the Point of Care Pediatric Respiratory Virus Panel is a safe, spill-proof, inexpensive, and simple to use design. The at home user should be able to easily follow all the included directions to effectively administer the test. At no point during the conduction of the test should there be significant risk to the user of contamination. The provided test result may be used as a diagnostic tool to help the user determine if a doctor or hospital visit is necessary.

Project Mentor: Colin Drummond, Biomedical Engineering

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Induced Pluripotent Stem Cell

Andrew Kim, Biology

Generate induced pluripotent stem cells (iPSCs) from primary tumor cells using two different methods: electroporation and lentiviral transfection.

Project Mentor: Barbara Kuemerle, Biology

Assembly of Marama chloroplast genome from Different Next-Gen Sequencing Reads

Yunsoo Kim, Systems Biology; Dr. Christopher Cullis, Department of Biology

Tylosema esculentum, which is also known as marama, is an underutilized arid legume in the Southern part of Africa. Marama chloroplast genome is being assembled de novo using two types of Next-Gen sequencing reads. The DNA was isolated from the leaves and then sequenced using two different platforms. The first was using the Illumina platform with100 base paired end reads from DNA that was sheared to approximately 500 bases in length. Secondly the PacBio platform was used to sequence very long reads from the DNA (more than 10kb). The Illumina data represented an approximately 100X sampling of the nuclear genome and a much lager oversampling of the chloroplast genome. The Illumina reads with similarity to chloroplast DNA were identified using Bowtie2 which aligned the reads to published chloroplast genomes of 12 different legumes and 8 different non-legumes. PacBio reads were aligned to the chloroplast genomes using BLASR. Three different assembly tools were used to assemble Marama chloroplast genome from the Illumina reads: SOAPdenovo, Newbler, and Velvet. All the chloroplasts containing contigs were concatenated and the duplicates were removed. Then, using CodonAligner all the contigs created along with the PacBio chloroplast specific reads were reassembled de novo into longer contigs. The assembled contigs were then rechecked using Blast against the non-redundant DNA database in NCBI to ensure that they were mainly chloroplast related. They were also aligned to various model chloroplast genomes to identify the closest evolutionary group and confirm co-linearity.

Project Mentor: Dr. Christopher Cullis, Department of Biology

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Optimization of Optical Based Malaria Detection

Seth Kimble, Engineering Physics

The detection of malaria present in humans has been shown to be possible by measuring the absorption of laser light as a magnetic field is applied to a blood sample containing the paramagnetic malaria hemozoin. However, current systems are impractical for use in wide range of environments and are subject to many sources of noise that prevent detection of low level infection rates. By designing an optical malaria detection device that uses sophisticated signal evaluation, low noise circuits, and rugged enclosures it is possible to detect malaria infection at one Plasmodium parasite per picoliter of blood or less.

Project Mentor: Robert Deissler, Physics

Persistent Switch Design for a Magnesium Diboride MRI Magnet

Sean Kinzler, Physics

Recent progress in magnet design and persistent joints used with a magnesium diboride, MgB2, superconductor has made clear the increasing importance of a persistent switch designed specifically for MgB2. The persistent switch is used to transform a section of MgB2 wire between superconducting and normal conducting states making it an integral part in a superconducting magnet. This project is focused on the design of the persistent switch for a 1.5T magnet to be used in an MRI machine. The design must meet the constraints required for proper operation in an MRI, including the operating current, stray magnetic field, and safety considerations. Transient and static thermal models were used to verify the energy efficiency and cool down time and to optimize the design.

Project Mentor: Mike Martens, Physics

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Linguistic and Cultural effects of Electronic Technology on the Aymara Language

Alayna Klco, International Studies, Cognitive Science

The Aymara people are most geographically concentrated in Altiplano Bolivia, northern Chile, and parts of Southern Ecuador. The Aymara are unique in their linguistic representations of time as compared to space in that the concept of past is perceived as in front of the speaker and the future is portrayed as behind the speaker. Aymara is the only known language in which this representation persists, but recent technological advancements and the increased levels of interaction between the Aymara and other South American cultures has started to reverse their spatial construction of time.

Language and culture are intimately linked and vital elements of Aymara culture are disappearing with the loss of the traditional language. Aymara bilingual youth demonstrate through gesture that they perceive the past as being behind them, and the increasing prevalence of electronic technology has expedited the process of linguistic and cultural integration (Nunez & Sweetser). This paper intends to explore the relationship between electronic technology, the reduced levels of isolation of the Aymara people and culture, and changing linguistic patterns while discussing the importance of and possibilities for preserving their ethnic heritage.

Project Mentor: Katia Almeida, Anthropology

MAGNET v.2.0: MicroArray & RNASeq Gene Expression Network Evaluation Toolkit

Shyam Kotak, Computer Science / Biology

MAGNET v.2.0. (MicroArray and RNAseq Gene expression and Network Evaluation Toolkit) is an online application that allows users to analyze large-scale expression datasets. The web application analyzes uploaded datasets and calculates the coexpression between genes (or proteins) in a gene list; or scores PPI networks utilizing a logistic regression model that includes tissue specific gene expression data, statistics based on known PPIs, co-clustering information, and co-localization data from public databases.

MAGNET v.2.0. allows users to filter the expression data and provides an efficient queuing system to handle large datasets and high traffic. With MAGNET v.2.0. implemented utilizing R, we are able to provide additional plots (histogram of interaction network edge weights or coexpression distributions) and p-values for the logistic regression models generated. The results of these tools are visualized on the website and also offered as text and Cytoscape readable formats.

This application will allow researchers to easily score their networks and study gene expression correlations. By providing users with a score for interactions in publicly available datasets, MAGNET v.2.0. allows researchers to confidently tap into the wealth of data found in the public domain through GEO, TCGA, or European Bioinformatics Institute (EBI) ArrayExpress. TCGA data is even housed on the MAGNET server, allowing users one-click access to gene expression data for 26 different cancers. The site is optimized to work with large datasets with ease, preventing the user from having to deal with cumbersome arrays prior to analysis. The tool is freely available to researchers and can be accessed with any up-to-date web browser.

Project Mentor: Gurkan Bebek, Center for Proteomics and Bioinformatics

Role of Glutaredoxin in Aging and Parkinson's Disease

Pavan S. Krishnan, Biochemistry; **Pierce Curran**, Biology, Psychology; **Bhooma Shivakumar**, Biomedical Engineering

Parkinson's disease (PD) is a neurodegenerative disorder characterized by degeneration of dopaminergic neurons in the substantia nigra of the midbrain. While the etiology of Parkinson's disease (PD) remains incompletely understood, aging and oxidative stress appear to play key roles in the loss of dopaminergic neurons during PD pathogenesis. Glutaredoxins (Grx1 and Grx2) are antioxidant enzymes that remove the oxidative stress-induced post-translational modification known as glutathionylation. Removal of this modification helps to maintain redox homeostasis. Caenorhabditis elegans (C. elegans), a microscopic soil round worm, is a widely utilized model organism for studying aging and neurodegeneration. Our previous study showed that Grx1 is deficient in midbrains of PD patients and genetic depletion of Grx1 homolog in C. elegans exacerbated dopaminergic neurodegeneration in worm models of PD. The present study explored the role of Grx2 homolog in aging and in PD pathogenesis. There are two isoforms of Grx2 that are present in the worms, Glrx-21 and Glrx-22. Using C. elegans with the Grx2 homologs genetically ablated, we examined the effects of Grx2 on life span and on dopaminergic survival in vivo. Age synchronized wild-type and Glrx-deficient worms were observed and their lifespan was recorded. Kaplan-Meier survival analysis was performed to compare the differences in life span between wild-type and Glrx-deficient animals. Our studies have found that worms lacking glrx-22 have a shorter life span compared to the corresponding controls. This finding suggests that deficiency in Grx2 has a negative effect on aging, a prominent risk factor for PD. Our ongoing experiments will further determine if deficiency in Grx proteins predispose dopaminergic neurons to oxidative stress induced cell death and PD pathogenesis. These studies may implicate a protective role of Grx proteins and provide useful insights regarding the development of therapeutic strategies for the treatmen

Project Mentor: Shu G. Chen, Pathology

Online Health Information: Why Credibility Is a Concern for This Important Resource

Margaret Landefeld, Anthropology

Health care information and health knowledge are increasingly becoming more accessible through online resources. This study looks at how online information on health can either be accurate or unreliable. There is a huge amount of online resources that are available to anyone with access to the Internet, but how easy is it to find reliable resources or how does someone know if they are looking at a credible source? By looking at this problem more in depth, it is apparent that the range of useful health information found online varies greatly. Although people can find websites that are useful and accurate for understanding health information, there are many websites for diagnosing symptoms that are fake or a scam to make money and have the user sign up for a service. This problem is important because the enormous collection of health information and resources online makes it difficult to assess the reliability of this information due to the lack of a system in place to regulate every source of health information online. It is important to recognize that this problem exists in order to raise awareness and begin to understand the difficulties with getting access to accurate health information. Due to the scope of the information online, it is only possible to look at a few sources in depth. Websites such as WebMD, the Mayo Clinic, the National Institutes of Health, and FamilyDoctor provide a range of health information that this review focuses on. With the use of online reviews of these websites as well as other articles discussing the validity of the health information, this research demonstrates that some online health information is not accurate. This has significant implications for how future online health information can be evaluated.

Project Mentor: Lee Hoffer, Anthropology

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The use of core scanning spectrometry to stratigraphically analyze the Utica Shale

Evan Lanese, Geology

There is a widespread need to understand how geological formations are distributed across three dimensions. Applications of this include oil, gas, and environmental management.   A critical tool for such 3D mapping is based on data from well-logs.The mineralogy in the Utica shale in southwestern Ohio is largely not understood. The goal of this project is to find trends in mineralogy with depth in this rock layer in one core sample so that it can be matched with similar trends in other core samples in the surrounding area and eventually create a map of the Utica shale. The trends can be used to evaluate how the rock was formed and the map can be used for oil and gas applications Methods of visible and near infrared (VNIR) reflectance which were analyzed with principal component analysis, gamma, x-ray diffraction, inorganic carbon and organic carbon. The VNIR reflectance data is used for high resolution data and the rest of the methods are used to back up this data. I will be presenting the mineralogical trends in the data that I found and how they relate to each other.

Project Mentor: Beverly Saylor, Geology

Optimization of Organic Photovoltaic Materials: Films and Interfaces

Kevin Laverty, Engineering Physics

In standard-architecture organic solar cells, the most commonly used transparent conductive oxide (TCO) is indium tin oxide (ITO), and the most common electron blocking layer (EBL) is poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS). Studies have demonstrated that PEDOT:PSS corrodes ITO, which deteriorates cell performance over time. The addition of a thin organofunctional silane layer has been shown to mitigate the corrosion. Additionally, silanes have been used as both EBLs and hole blocking layers (HBLs) in standard and inverted architecture OPVs, respectively. In this work, the deposition of a thin monolayer of diphenyldiethoxysilane (DPDES) was investigated as an interlayer between the ITO and PEDOT:PSS and also as a standalone EBL. A deposition protocol for DPDES was developed. Silane deposition was confirmed using contact angle measurements and Fourier transform infrared spectroscopy, and thickness was measured using spectroscopic ellipsometry. After reproducible conditions were achieved, solar cells were produced with DPDES and DPDES + PEDOT:PSS as the EBL and compared to control cells which utilized PEDOT:PSS as the EBL. Adding DPDES in addition to the PEDOT:PSS resulted in a slight reduction in cell efficiency (from 4.5% to 4.0%). The silane only cells had a significant reduction in efficiency, to 1.1%. Previous research done at the MORE Center determined that using another silane, (3?aminopropyl) triethoxysilane (APTES), as the EBL produced an average efficiency of 0.2%. These results indicate that the termination of thin interfacial layers between the bulk heterojunction absorber layer and the ITO affect the efficiency of the resulting solar cell greatly. Further work will need to be done in order to determine the long term response of modifying the ITO interface with DPDES in standard-architecture, organic solar cells.

Identifying the role of candidate genes on female fertility in hybrids of closely related Drosophila species

Hyun Lee, Biology

CG 6226 and CG 3919 were identified as candidate genes that cause infertility in hybrid females between D. melanogaster and D. simulans species. Previously, it was found that knocking down these genes in the germline of D. melanogaster females using RNAi causes a skew their offspring's gender ratio toward females. We hypothesized that these candidate genes result in hybrid female infertility and maintaining correct offspring gender ratio by playing a significant role in either the dosage compensation mechanism or the transposon activity-suppressing pathway in the female germline. To test the hypothesis of dosage compensation, we used Gal4/UAS-RNAi technique to obtain first-generation (F1) flies with each of the candidate genes knocked down. Then, we mated the F1 females with wild type males in order to observe the expression intensity of sog (an X-linked gene) and twist (an autosomal gene) in the embryos laid by the F1 females. Our goal is to compare the expression ratio of the X-linked and autosomal genes in experimental embryos and wild type embryos, and determine if the X-linked gene expression is abnormally decreased in males. These experiments are currently ongoing. We tested the second hypothesis that the candidate genes are pivotal in the PIWI Pathway, which works to suppress transposon activity in female germline, thereby preventing unwanted mutations from occurring. In order to test this hypothesis, we stained the ovaries of F1 flies expressing RNAi to detect three key proteins of the PIWI Pathway: PIWI, AGO3, and Aubergine. Our results suggest that the Aubergine localization in the nuage region is altered in the 6226 RNA ovaries and that the PIWI and AGO3 expression level are decreased in the CG 3919 RNAi ovaries. These results suggest that our candidate genes for hybrid female fertility function by affecting the PIWI pathway.

Project Mentor: Claudia Mizutani, Biology

Evaluating Polymer Durability as Measured by Thermogravimetric Analysis

Alexander Leong, Undecided; **Christian Grimme**, Biomedical Engineering; **Justin Beiriger**, Biomedical Engineering

This study summarizes the results of thermogravimetric analysis (TGA) on various medical-grade and non medical-grade polymers. Higher thermal stability polymers result in more durable and therefore more suitable implant material for use in the human body. For example, polyether ether ketone (PEEK) is one of the best medical grade implant polymers due to its high thermal stability (by peak dTGA temperature) and melting temperature ($Tm = 323$ C).

Second derivative analysis displays more detailed data than first derivative analysis (dTGA) during intense heating.This method requires determining the first derivative of the original data, showing the rate of mass change as temperature is increased.The second derivative graph shows a breakdown of first derivative analysis that highlights the multiple substances that volatilize within each first derivative peak. Second derivative analysis highlights asymmetries in seemingly symmetric first derivative peaks. In doing so, the various structural complexities of the polymer become apparent.

The data collected from the TGA indicated that polymers decompose in steps as they are heated, represented by second derivative peaks. Results indicate fewer second derivative peaks correspond to fewer structural variations and defects present in the polymer. Low density polyethylene has four second derivative peaks, corresponding to lower thermal stability, compared to high density polyethylene, which has three peaks. By analyzing the first and second derivative of decomposition of polymers using TGA, we determined the most implant-suitable polymers.

Project Mentor: Dr. Alan Riga, Macromolecular Science and Engineering (Polymer Science)

A Hybrid Neuromechanical Assist System for Stand-to-Sit Manuever

Maria Lesieutre, Mechanical Engineering

The overall goal of the Hybrid Neuroprosthesis (HNP) Project is to "develop and fabricate a new, self-contained and multifunctional hybrid neuroprosthesis suitable for clinical testing out of the laboratory setting" (1). The project combines functional neuromuscular stimulation (FNS) with an advanced hydraulic orthosis to help restore mobility to individuals after spinal cord injury (SCI). People with SCI do not always have full use of their lower extremities. Standing and walking can be restored using braces and/or FNS. However, tasks like sitting down from a standing position in a controlled fashion can be difficult. When an individual goes from stand-to-sit the quadriceps muscles eccentrically contracts to damp the motion. An eccentric motion is when a muscle lengthens and contracts simultaneously. This can be difficult to control using FNS. Uncontrolled sitting can be dangerous for individuals with SCI because it can cause further injuries.

The goal of this project was to design a knee mechanism with a hydraulic proportional valve circuit that allowed the HNP to provide support and to control the sitting motion. To determine the best mounting system, multiple scenarios were run through an optimization algorithm that varied the percentage of measured able-bodied torque limits and other variables. The optimal mounting position was chosen, and brackets were designed and machined. Preliminary experiments were performed to evaluate the circuit's ability to control the stand-to-sit maneuver for a subject with SCI. Testing resulted in the right side cylinder rod bending due to a bending moment placed on cylinder rod. Future testing will be done with the hydraulic proportional valve circuit on the newest version of uprights to evaluate the knee mechanism's ability to better control the stand-to-sit maneuver for individuals with SCI.

1. A HYBRID NEUROMECHANICAL AMBULATORY ASSIST SYSTEM. Joint Warfighter Medical Research Program, Proposal Number 12229045

Project Mentor: Ronald Triolo, Biomedical Engineering

Prostate Capsule and Central Gland Delineations on MRI by an Expert Radiologist and a Novice Show Surprisingly Good Agreement

Caroline Lettrich, College Prep

Prostate cancer has a different appearance in the two anatomic regions of the prostate, the peripheral zone and the central gland, on MRI. An accurate segmentation of both regions is crucial for developing spatially computer assisted prostate cancer detection tools. Additionally these segmentations are important in that they could serve as the "ground truth" for evaluation of computer assisted segmentation algorithms. With the profusion of medical imaging data now publicly available through such resources as The Cancer Imaging Archive (TCIA) and the lack of time and effort on the part of expert radiology readers to manually segment the imaging studies, there is interest in using a "crowd-sourcing" model (i.e. using non-experts) to generate these segmentations. However the variability in segmentation of the prostate capsule as well as the central gland by different readers on MRI is well known and documented. While one might expect that the inter-observer agreement in the segmentation of the capsule and the peripheral and central zones on MRI is high between expert radiologists, there has not yet been a rigorous quantitative evaluation of the level of agreement in segmentation performance between expert radiologist and novice, non-expert readers. In this work we evaluated the variability in segmentation in the peripheral zone and central gland between an expert radiologist and a novice reader. Both the expert radiologist and novice user segmented the two zones manually, using a medical imaging software program called 3D Slicer. We observed an overlap of 88% for the entire prostate and 83% for the central gland between the expert and novice readers. The lower overlap in the central gland it likely an outcome of the central gland beings a smaller structure. Most differences were observed at the base and the apex of the prostate, known to be notoriously difficult to segment.

Project Mentor: Anant Madabhushi, Biomedical Engineering

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The Relationship Between Parent Anxiety, Parental Behaviors, and Child Play

Kathy Lin, Psychology

Child social skills are developed, in part, based on parent-child interactions. Maladaptive interactions with parents may undermine a child's sense of confidence and security in social interactions, which may then impact the child's interactions with peers (Cohen & Mendez, 2009; Garner & Estep, 2001; Eisenberg, Fabes, & Murphy, 1996). Maladaptive parenting practices are also associated with parental anxiety (Bayer, Sanson, & Hemphill, 2006; Hirshfeld et al., 1997). Anxious parents are more critical and show less affection, positive regard, and encouragement of psychological independence towards their children than do non-anxious parents (Turner, Beidel, Roberson-Nay, & Tervo, 2003). Thus it is likely that parents who are anxious are engaging in maladaptive parenting, therein contributing to poor social skills in children. The current study looked at parent anxiety, parenting styles, particularly parent's reactions to child negative emotions and parental psychological control, and child social skills for the purpose of better understanding the link between them in a structured peer play task in a non-clinical sample of children ages 4-7. Preliminary results indicated that parental anxiety was associated with child aggressive ($r = .43$, $p < .05$) and nonsocial play ($r = .37$, $p = .05$) as well as maladaptive parenting strategies (punitive reactions to child negative emotions, $r = .45$, $p < .01$; and parental psychological control, $r = .34$, $p < .05$). Maladaptive parenting behaviors were also associated with poor child play variables. This illustrates that parenting may be the potential path by which parental anxiety contributes to poor child social skills.

Project Mentor: Amy Przeworski, Psychology

Optical Inhibition for Rapid and Reversible Block of Axonal Sub-Populations

Emilie Lothet, Biology and Cognitive Science

Chronic pain is a widespread disorder that, for the moment has limited treatment options. Currently, the available methods to deal with chronic pain are pharmaceuticals and surgery, two techniques lacking in real-time control. Kilohertz High Frequency Alternating Current (KHFAC) is a new, viable alternative that allows for complete, long-lasting and reversible block of action potentials. However, one of the characteristics of KHFAC is a prominent onset response, a high-frequency, high-amplitude period of neural activity, that arises when the high frequency waveform is turned on. We have previously demonstrated that it is possible to block the onset response by applying an infrared (IR) laser. Among the advantages that infrared light has over electrical inhibition is the spatial specificity it provides. To explore infrared as a modality for control of pain, all of the experiments were conducted on the Aplysia californica's unmeylinated axons, a good model to predict the behavior of mammalian, unmyelinated, pain-conducting C fibers.

We subsequently found that complete neural block could be obtained using the infrared laser alone. Moreover, we found that we were able to obtain block of the Aplysia californica's unmeylinated nerve with an axonal subpopulation resolution. More specifically, we were able to block the small-diameter, slow-conducting axons before affecting the larger-diameter, faster-conducting axons using IR light. This is significant because, in the Aplysia animal model, it is known that large-diameter axons are associated with motor commands and that small-diameter axons are associated with sensory signals. Heat experiments have indicated that the infrared light is affecting the nerve's conductive properties via a thermal mechanism. We also found that the infrared laser has the capacity of producing a complete block of an Aplysia nerve under 30msec, a speed that would allow for a closed-loop control system.

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Project Mentor: Hillel Chiel, Biology, Biomedical Engineering, Neuroscience

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Characterization of Subradular Muscle Fibers as a Radula Opener in Aplysia californica

Sisi Lu, Biology, Medical Anthropology

The biomechanics and neural control of feeding behavior in the marine mollusk, Aplysia californica, are studied in order to understand mechanisms of learning, neuromodulation, multifunctionality, and motivated behavior. This project focuses on one aspect of the Aplysia buccal mass, a structure of muscle and cartilage used for feeding. Inside the buccal mass is a cartilaginous structure called the odontophore that provides support and mediates the opening and closing of a rough, grasping surface. In previous studies of the odontophore, the muscle group, I-7 is characterized as the primary surface opener. However, preliminary data in this lab has shown that when I-7 is removed in lesion studies of feeding animals, opening does not appear to be reduced. We have found that the activation of a small group of muscle fibers under the grasping (radular) surface, Sub-radular fibers (SRF), can produce openings when all other muscle groups, including I-7 are removed in a reduced preparation. Therefore, the SRF may also play a significant role in openings for a feeding organism. This research focuses on characterizing these fibers and their suspected role in opening. We performed muscle recordings on the SRF in a semi-reduced, suspended preparation to confirm the synchronicity of electrical activity and the associated opening behavior. We also performed lesions of these fibers in live Aplysia and compare changes in opening behavior to the un-lesioned preparation. This project can help expand the literature on Aplysia anatomy and feeding physiology to help the systems biology community improve current models of the flexibility of motor patterns.

Project Mentor: Dr. Hillel Chiel, Biology

Childhood Obesity: A Comparative Study of Cleveland, Ohio and Copenhagen, Denmark

Roxanne Lyter, Nursing; **Katharina Webster**, Nursing; **Mackenzie Dunn**, Nursing

This research strives to assess whether dietary preferences, political and government dissimilarities and cultural variations are responsible for the significant differences in childhood obesity prevalence rates in Cleveland, Ohio and Copenhagen, Denmark. Researchers used a compilation of qualitative studies, descriptive articles and observations to assess the impact these influences had on such prevalence rates. The results concluded that the differences in childhood obesity rates between these two locations are indeed greatly affected by these factors.

Project Mentor: Jesse Honsky, nursing

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Drug delivery of small interfering RNA as a therapy for triple-negative breast cancer

Margaret Mack, Biomedical Engineering

Small interfering RNA (siRNA) has been shown to be effective in regulating gene expression in cancerous tumors. In previous studies, eukaryotic translation initiation factor 4E (eIF4E), has been found to be overexpressed in metastatic and malignant tumors. eIF4E overexpression has been linked to an overproduction of a number of genes implicated with tumorigenesis and drug resistance. Therefore, the use siRNA to target eIF4E causes the level of the gene to drop, which can resensitize cancer cells to chemotherapies. In this study, the effect of eIF4E silencing using siRNA was tested on a drug resistant cell line. During in vitro studies, through the use of PCR, significantly lower mRNA expression of eIF4E was achieved in both a normal cell line of MDA-MB-231, triple negative (TN) breast cancer cells, and a drug resistant cell line when siRNA targeting eIF4E was used. Furthermore, western blot studies returned similar results for the protein level expression of eIF4E. Before moving into in vivo studies, cell viability studies were done to determine the effect of coupling siRNA and paclitaxel, a commonly used chemotherapy. In addition, to causing cell cycle arrest, siRNAs targeting eIF4E have been found to resensitize drug resistant cells to small-molecule chemotherapies. Therefore, while treating mice being primary tumors of drug-resistance MDA-MB-231 cells, one experimental group was given a combination treatment of paclitaxel and siRNA. Significant tumor growth inhibition was found in this set of mice compare to mice receiving only paclitaxel or siRNA. After 6 weeks of treatment, the primary tumors were removed the expression of eIF4E was evaluated with PCR. The results validated our in vitro findings; there was significantly lower expression of eIF4E in the tumors treated with siRNA targeting eIF4E.

Project Mentor: Dr. Z-R Lu, Biomedical Engineering

Role Of Rb/E2f1 In Neuronal Cell Cycle Re-Entry In The Pathogenesis Of Alzheimer Disease

Maaryah Malik, College Prep

Alzheimer's disease (AD) causes cognitive dysfunction and memory loss. Neurons do not divide once initially formed, but neuronal cell cycle re-entry is a feature of AD that may contribute to neuronal death; however, the mechanism remains unknown. Transgenic mouse models with altered retinoblastoma protein (Rb) and E2F1 genes have been used to examine how re-activation of cell cycle can lead to neuronal cell death. Rb prevents cell cycle by inhibition of E2F protein family, in the present study E2F1 was completely knocked out in one mouse group (homozygous) to test whether it is the main factor in driving cell cycle. If true, these neurons would not experience any cell death; i.e. without E2F1, neurons would not re-enter cell cycle and die. Additionally, mice with only one allele knocked out (hemizygous) were tested. Brain sections from hippocampus and cortex of these mice and controls were tested for cell cycle and DNA damage using specific antibodies (PCNA for cell cycle and rH2AX for DNA damage) and quantified for statistical analysis (Student's t-test and ANOVA). In the homozygotes (N=6), there was unexpected hippocampal cell cycle re-entry, and DNA damage, while, in cerebral cortex, DNA damage, but not cell cycle re-entry, was notably reduced. In the hemizygotes (N=5), there was notable hippocampal cell cycle re-entry and DNA damage but only DNA damage in cortical neurons with no substantial cell cycle re-entry. In conclusion, genetic modification of Rb/E2F1 signaling results in different neurodegenerative changes in hippocampal versus cortical neurons, which suggests the differential role of Rb/E2F1 signaling in these two distinct neuronal populations.

Project Mentor: Hyoung-Gon Lee, Pathology

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Improving the Low Temperature I-V characteristics of Molybdenum Di-Sulfide (MoS2) on Hexagonal Boron Nitride (h-BN) Devices

Vipul Malik, Engineering Physics

Molybdenum disulfide (MoS2) transistors have attracted considerable attention. Molybdenum disulfide (MoS2) transistors on boron nitride (BN) substrates in particular show interesting I-V characteristics. Unfortunately these transistor devices currently exhibit undesirable I-V characteristics at low temperatures due to the degradation of the MoS2 contacts at low temperatures. This project focuses on mastering device fabrication and improving device I-V characteristics at low temperatures. In order to master device fabrication, understanding the techniques of exfoliation and transfer for the MoS2 is necessary, along with other techniques such as annealing of the contacts. After the base device layer is made, a second layer of metal will be added to the contacts of the device. This metal layer will be added by evaporation through a stencil mask, etched using a focused ion beam. The new device will then be brought down to low temperatures and tested in order to evaluate and understand its I-V characteristics.

Project Mentor: Philip Feng, EECS

PEGylation for Improved Melt Processing of Proteins

Melissa Martinez, College Prep

Proteins often denature and aggregate during current solvent based processing methods due to destabilization of polar or non-polar areas. Hot-melt extrusion of protein-polymer blends is a promising processing method because it does not use aqueous or organic solvents, avoiding denaturing solvation effects. Research has shown that native proteins can be successfully processed within a PLGA polymer matrix and retain activity. This project aims to improve the stability of lysozyme (a model protein) using covalently attached PEG units.

Lysozyme modified with PEG is processed with PLGA, a biocompatible polymer, to create a protein-polymer implant for biomedical applications. The protein structure is monitored before and after processing using FT-IR and CD spectroscopy. The release and activity of the protein is monitored using a Bradford and cell lysis study. The conformational stability of the protein is monitored during processing conditions using in situ FT-IR Rheometry, giving good insight into the dynamics of protein stability. This project can have applications in protein processing for cancer treatment and vaccine stabilization.

Project Mentor: Parker Lee, MSE

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Time-Dependent Deformability of Adhered Sickle RBCs Under Physiological Flow

Yumi Matsuyama, Mechanical Engineering

Red blood cell (RBC) adhesion and deformability are the main causes leading to blood vessel occlusion in sickle cell disease (SCD). Here, we present a microfluidic system along with a cell dimensioning algorithm to analyze deformability of adhered RBC at single cell level under precisely controlled flow conditions. The microfluidic channels are coated with Fibronectin to mimic blood vessel adhesive characteristics. We analyzed and compared dynamic deformability of healthy hemoglobin A (HbA) and homozygous sickle hemoglobin (HbS) containing RBCs in patient blood samples. We introduce a new parameter to assess deformability of RBCs: the dynamic deformability index (DDI). DDI is the rate of deformation, which is defined by the change in aspect ratio.

Non-pre-processed blood samples are injected to microchannels at controlled flow rates by using a syringe pump. After blood flow, channels are washed to remove non-adherent cells. Controlled fluid flow with stepwise increments of 10 µl/min from 40 ul/min to 500 ul/min is applied until the detachment of analyzed RBCs. Real-time videos of RBC deformations under applied fluid flow are recorded at 7 frames per second rate and converted to single frame images for further analysis. We observed subgroups of HbS containing RBCs: HbS deformable and HbS non-deformable.

HbA-containing RBCs showed significantly greater DDI than HbS-containing deformable and non-deformable RBCs after two seconds into deformation (Kruskal-Wallis and Mann Whitney test, n=3-6, $p<0.05$). This indicates that healthy RBCs are deforming at a much quicker rate to reach their stable deformed state than HbS Non-Deformable and HbS Deformable RBCs for flow velocities resulting in cell detachment. HbS-containing deformable RBCs displayed significantly higher DDI than HbS-containing non-deformable RBCs($p<0.05$). In summary, we present a microfluidic system integrated with an image processing algorithm to measure and analyze dynamic deformability index of adhered RBCs.

Project Mentor: Umut Gurkan, Mechanical and Aerospace Engineering

The Viability of Phytomedicine as a Possible Solution for Antibiotic Resistance

Caitlyn McGillis, Biology

Phytomedicine is the use of plants, or specific parts of plants, as well as phytochemicals as a treatment or in prevention of several health issues. This field falls under the larger umbrella of integrative medicine, which has been utilized by the American public at greater rates throughout the recent decade. Phytomedicine is being researched as a possible solution to the worldwide problem of antibiotic resistance. This is an area that desperately needs to be researched as the number of antibiotic resistant strains of bacteria have only been growing with the increasing number of antibiotics being prescribed in the United States, leaving hospitals extremely vulnerable to the evolution of these "superbugs". There have been many studies completed recently in regards to specific phytochemicals and their effect on methicillin-resistant Staphylococcus aureus (MRSA) and Helicobacter pylori. Phytomedicines have varying modes of action, and they can also be used in tandem with particular beta-lactams and carbapenems, such as EGCg and imipenem, to have a synergistic effect on eradicating the infective bacteria. The results of these studies have indicated the benefits of the synergistic effect, but phytomedicines alone have been less studied as a treatment option. Curcumin, a studied phytomedicine from ginger, has been found to decrease the severity of symptoms in patients in certain bacterial infections. Ultimately, certain phytomedicines can be new and effective bactericidal agents.

Project Mentor: Dianne Kube, Biology

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A Review of the Effects of Gendered Language on Norms, Beliefs, Cognitive Biases And Sexist-Based Prejudices

Kelly McGuire, Cognitive Science

This review blends together the literature on the relationship between gendered language and cognition, focusing on the interaction of gender-based cognitive biases in both language and linguistic strategies in the educational setting. Language is a communication tool that is able to embody a representation or a presentation of our socially constructed selves, and as previous studies have shown, language is able to reflect a culture's power structures based on speech patterns, linguistic strategies, and a society's gender-based expectations for how people present themselves. In an educational setting, gender bias hinders fair communication between a teacher and their male and female students, and signs of sexism in textbooks and exams can perpetuate harmful gender-based stereotypes that perpetuate norms and expectations for men and women. Such prejudices can manifest themselves in a language's expressions, metaphors, and even in the grammar itself. By combining data on linguistic strategies for men and women in a cultural perspective and the relationship between language and cognition, the review attempts to apply the data to gender bias in classrooms and analyzes research that could potentially serve to correct gender bias in the language surrounding an educational environment.

Project Mentor: Vera Tobin, Cognitive Science

Self-Care Management Benefits Oral Health in Postmenopausal Women

Sara Mithani, Nursing

Periodontitis is a gum disease that destroys the bone that supports your teeth and damages other soft tissues in the oral cavity. Menopause is often associated with periodontitis and tooth loss. Postmenopausal women are at higher risk for developing periodontal diseases due to a deficiency of the female hormone, estrogen. Research has shown that there is a need for additional oral hygiene education for postmenopausal women. Furthermore, studies report a need for better home care in this cohort. To compare plaque score and inflammatory cytokine concentration in the gingival crevicular fluid before and after self care instructions. 30 otherwise healthy postmenopausal women participated in this study. Plaque scores were measured at T0 and again 1 week after self-care instructions were given. Gingival Crevicular fluid cytokines were likewise collected at T0 and T1, analyzed using ELIZA and IL13, IL1alpha, IL1 Beta IL4, IL6 TNFalpha were measured and compared between timepoints. Plaques score was not significantly lower at T1 vs. T0. 21 of 30 samples presented with analyzable GCF. IL13(4.89 +_ 3.43 vs 3.05+- 1.976 p=0.049), IL1beta (1682.97+- 1091.34 vs. 597.004+- 528.54 p=0.0004), and TNFalpha (4.312+- 2.82 vs. 1.085 p=0.00547) were significantly different after self care instructions. Self-care instructions improve gingival crevicular fluid Inflammatory biomarkers where plaque scores do not show significant difference. Perhaps there is a need for more discreet biomarker analysis in assessing outcomes of oral health interventions.

Project Mentor: Leena Palomo, Periodontics

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Robotic Implementation of Cockroach Survival Mechanisms in Response to Praying Mantis Predation

Genesis Mlakar, Mechanical and Aerospace Engineering; **Lyall Glait**, Systems Biology; **Eli Gold**, Biology

Our goal in performing this study was to adapt an existing cockroach robot to increase its chances of survival while being hunted by a praying mantis robot (see Robotic Implementation of Praying Mantis Predation Behavior as Observed through Artificial Cockroach Stimuli). Both robots have been programmed to move in patterns resembling their species, and the praying mantis robot is capable of hunting the cockroach robot. The behavior of the cockroach is based on biological studies of live cockroach behavior. We conducted trials examining which types of behaviors most increase and decrease chances of survival, and the robots have been programmed to use behaviors that will minimize their chances of being eaten.

In particular, staying near a wall was found to increase chances of survival compared to being out in the open. Since cockroaches make extensive use of their antennae when navigating their environments, we also performed a close examination of antennal behavior in adult cockroaches navigating a novel environment. Close footage of this behavior was obtained with a gantry under a clear arena, which could track and film a cockroach as it looked for shelter. The cockroach robot is an autonomous, treaded vehicle with custom built, tactile antennae. Its control algorithm simulates this shelter-seeking behavior by actively maintaining proximity to a wall by antennae contact.

Cockroach cerci are wind sensitive sensors on the rear of the cockroach, which allow it to detect potential predators from behind. Additions to the cockroach robot include a proximity sensor attached to the back of the chassis, to simulate these cerci. When the praying mantis robot comes within range of the sensor, the cockroach robot will perform an appropriate escape response.

Project Mentor: Roger Quinn, Mechanical and Aerospace Enigneering

Connecting the Optical, Structural and Spin-Dependent Properties for Films of Quantum Dots

Zaarah Mohamed, Physics

The proposed project aims to discern the connection between structural, optical, and spin-dependent properties for films of semiconductor nanoparticles. These films are to be created through various methods involving solutions of quantum dots (QDs), and will vary in thickness and uniformity. The structural and optical properties of these films are to be measured using atomic force microscopy (AFM) and optical spectroscopy; light/spin interactions are then to be characterized in a pump-probe Faraday rotation experiment. By systematically varying the film deposition parameters, connections between the films' structural, optical, and spin-dependent properties will be explored. An understanding of how the deposition parameters affect these properties will enable experiments that require high concentrations of QDs, and ultimately may find application in integrated spintronic/photonic devices.

Tentative results include visual evidence that the use of dried QDs (produced from precipitating the QDs from their original solution) combined with a solution of hexane and octane yield more uniform films. Optical data from other methods of film synthesis that showed no correlation between films' composition and their optical properties also imply that this method is generally superior to drop-casting methods that involve synthesizing the films using the original solutions of QDs in toluene in combination with a volatile solvent.

Project Mentor: Dr. Jesse Berezovsky, Physics

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Using Flow Cytometry and Quantitative Real-Time PCR to Investigate the Role of IL-1? in T-Cell Proliferation and HIV-1 Reactivation

So Hee Moon, Chemical Biology

With the advent of antiretroviral therapy, suppressing the HIV-1 virus and stopping the progression of the disease are now possible. Even with long-term antiretroviral therapy, HIV reservoirs remain in individuals. These individuals experience an increase in inflammatory cytokines such as IL-6 and IL-1beta that results in the proliferation of CD4 T-cells. In this study, we explored the relationship between inflammatory cytokine-induced proliferation and reactivation. To assess this relationship, we investigated the role of a specific inflammatory cytokine, IL-1beta. It was concluded from our experiments that CD4 T-cells are able to proliferate in the presence of IL-1beta. Although IL-1beta may not induce overt reactivation of HIV-1, as shown in the flow cytometry data, further studies need to be conducted to see whether or not IL-1beta propagates the reservoir.

Project Mentor: Dr. Rekha Srinivasan, Chemistry

Diamond Films for Integrated Spectroscopy

Andrew Moore, Chemical Engineering

The focus of this research was creating a diamond-coated polymer waveguide to be used in rapid detection of neurotransmitters, such as dopamine and serotonin. The goal was to use light, ultraviolet-visible or infrared, to detect concentrations of neurochemicals in a system using a waveguide, very similarly to a fiber optic light. The light source would feed into a polymer waveguide, travel to a detection sight, where some of the light would be absorbed, and the absorbance would be collected at the light detector. This efficient process could be used to detect abnormalities in chemical levels of patients with Alzheimer's disease, Parkinson's disease, or any neurochemical related disease. This specific leg of the project includes research specifications found by synthesizing information in various published papers and determining the structure and process for constructing such a device. Observations were taken and recorded for various preliminary standards of light transmittance through the polymer and colored liquids. Together, the design and observations will be used to create and demonstrate the capabilities of waveguide guided light to rapidly measure concentrations.

Project Mentor: Heidi Martin, Chemical Engineering

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Calculation of Total Cost of Energy Sources Considering Externalities

Christopher Mudry, Geological Sciences

Energy sources are often compared to one another to determine the economic efficiency and environmental impact relative to one another. However, these two comparisons are often disparate, as the externalities due to energy generation are not easily quantified. It is my goal to quantify these externalities and apply monetary costs to each externality. These additional costs will be added to the Energy Information Agency estimated cost of each energy source. In doing so, a total cost can be calculated, with error bars to account for the assumptions required to complete this calculation.

Project Mentor: Beverly Saylor, EEPS

Closed-Loop Blood Pressure Monitoring Feedback for Application with Intrathecal Drug Delivery Systems

Timothy Nevin, Biomedical Engineering; **Ro Jie Li**, Biomedical Engineering; **Adam Boe**, Biomedical Engineering

Intrathecal drug delivery systems (IDDS) consist of a programmable pump attached to a catheter and are currently in clinical use for the treatment of chronic pain and spasticity. Typically, these systems can either deliver a small volume (0.2-1.0 ?L) of concentrated medications continuously over a 24-hour period or deliver a bolus of a given volume (usually 20-100 L) at a rate of about 10 ?L/min. However, given our current understanding of cerebrospinal fluid flow, the majority of a medication administered intrathecally at current low pump delivery rates has been shown to remain at or very close to the catheter tip with small or inaccurate dispersion patterns. We hypothesized that with accurate blood pressure monitoring in real time, more specific injection parameters and thus better drug dispersions can be obtained. A common side-effect of intrathecal injections of morphine for chronic back pain management is a drastic drop in blood pressure. Additionally, it is known that an individual's heart rate and breathing rate directly affects the flow of their cerebrospinal fluid. Continuous blood pressure monitoring could utilize both of these notions to better control the intrathecal drug delivery systems. With this hypothesis, a prototype feedback system was designed, fabricated, and tested. The results of this project are currently being used in study to advance the application of intrathecal drug delivery systems beyond that of chronic pain and spasticity.

Project Mentor: Dr. Colin Drummond, Biomedical Engineering

Hormone replacement therapy, reproductive factors, and risk of colon adenomas in Caucasian and African American women

Anthony Nguyen, Psychology, Chemistry; **Shreya Sekaran**, Nutritional Biochemistry and Metabolism

Introduction: Estrogen has been shown to play a protective role against colorectal adenomas and cancer. In this study, we evaluated both exogenous and endogenous markers of estrogen exposure in relation to colon adenoma risk and its relationship to race.

Materials and Methods: As part of an ongoing clinical trial on colon cancer screening, we recruited patients who were referred for a colonoscopy at University Hospitals in Cleveland, OH. Prior to colonoscopy, demographic information and medical history were collected via a computer-assisted telephone interview.

Results: In our population of 1581 women, 879 (55.6%) self-identified as Caucasian and 659 (41.7%) as African American. For women with a history of hormonal replacement therapy (HRT), there was a significant reduction in colon adenoma risk (OR= 0.67, 0.47 to 0.93, p=0.017). When stratified by race, Caucasian women who had a history of HRT use were at a reduced risk (OR=0.57, 0.34 - 0.87, p=0.0113) relative to African American women who showed no significant difference in risk (p=0.46). In addition, more women who had menstrual periods while on HRT also showed a decreased risk of adenomas (OR= 0.56, 0.30 to 0.96, p=0.0436). Similarly, this was limited to Caucasian women (OR= 0.40, 0.18 to 0.80, p=0.0156) and African American women who had menstrual periods while taking HRT showed no difference in risk (p=0.58). For markers of endogenous estrogen exposure, we observed no significant different risk for: parity, age of menarche, age of menopause, and lifetime estrogen exposure (menopause - menarche).

Conclusions: Results have shown that there is a significant reduction in risk of colon adenoma in women with a history of HRT and those who had menstrual periods while taking HRTs. Interestingly in our study, this reduction in risk was limited to Caucasian women and further studies are warranted to understand the underlying biological mechanisms.

Materials Development for Large Scale Production of Organic Light Emitting Diodes

Taylor Nguyen, Material Science and Engineering

The goal of this project was to develop a methodology to fabricate flexible organic light emitting diodes (OLEDs) using solution processable materials. We studied two solution-processable materials, poly(9,9-dioctyl-2,7-fluorene) (PFO) and poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT:PSS) that can be prepared near room temperature conditions. PFO was tested as an emissive layer, and PEDOT:PSS was tested as an anode. A range of deposition and annealing rates were examined for both PFO and PEDOT:PSS. The resulting film properties were assessed using optical microscopy and optical profilometry to determine surface features and homogeneity, and spectroscopic techniques to measure film thickness and transmission/absorbance. Optimized PFO deposition and annealing conditions resulted in functional standard OLED devices, with blue emission that was constant for more than 25 minutes. After PFO was standardized, post-deposition solvent treatments were developed and tested on PEDOT:PSS. These treatments increased the conductivity of PEDOT:PSS by 2-3 orders of magnitudes. Using the higher conductive PEDOT:PSS, totally solution-processed OLEDs were fabricated.

Project Mentor: Mohan Sankaran, Chemical Engineering

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Incorporation and Data Analysis of an Ankle Moment Transducer for Intraoperative Testing of C?FINE Nerve Cuff Electrodes

Remy Niman, Biomedical Engineering

Implanted motor system neuroprostheses employing electrical stimulation to intact peripheral nerves can significantly improve the health and daily functioning of individuals with Spinal Cord Injury by providing a means to contract the otherwise paralyzed muscles. During implantation surgery, nerve cuff electrodes are placed around the target nerve and then stimulated. In order to determine how well and in what ways the stimulation is causing the muscles to contract, Electromyography (EMG) is taken on the appropriate muscles. The disadvantages to this method are that it takes a long time to set up the EMG, the electrodes often fall out during stimulation, and it is an indirect measurement of the forces and torques produced by the muscles acting on the bones. In order to directly measure the ankle moments produced by nerve cuff electrodes, new instrumentation must be developed for use in the Operating Room during the implant procedure. This paper discusses the design process followed to manufacture a device that can be used within the sterile field and differentiate ankle moments produced in the plantarflexion, dorsiflexion, eversion, and inversion directions. A Sunrise Instruments M3933 Load Cell programmed with MATLAB 7.1 software was used to measure the ankle torques.

Project Mentor: Dr. Ronald Triolo, Biomedical Engineering and Orthopedics

Posture Dependent Control of Lower Extremity Stimulation with a Standing Neuroprosthesis

Benjamin Nudelman, Biomedical Engineering

After a spinal cord injury (SCI), individuals may lose the ability to stand up and maintain an erect standing position for long periods of time. Due to advances in functional neuromuscular stimulation (FNS), we are able to stimulate paralyzed muscles, allowing SCI subjects to regain functional use of their lower extremities. A caveat of the stimulation is that it is currently not able to account for changes in center of mass of the subject, necessitating the use of arms and a walker for balance. By measuring minute changes in center of mass, we are able to develop a system for instantaneously changing the stimulation in the legs, counterbalancing the effect of motion and freeing up the use of arms for functional purposes. This system is known as a "posture follower", capitalizing on the use of a "set-point" controller to continuously change the set-point from which a signal is sent. In order to develop a system for translating changes in motion to stimulation, we used precise measurements of body length segment kinematics to develop a musculoskeletal model. Working from previously collected data and algorithms, we created a database used to input subject specific characteristics such as height and weight to output values of body segment length, body segment mass, radius of gyration, and moment of inertia. We focused on segments within the upper and lower extremities such as forearm, upper arm, thigh, lower leg, and foot. While testing the accuracy of the database, we determined that upper leg and upper arm segments contained the largest variability. With standard deviations of .08 and .055 as ratios of length to height for upper leg and upper arm respectively, we determined that exact subject specific information would need to be collected. We are currently in the modelling phase of the project, using software such as Software for Interactive Musculoskeletal Modeling (SIMM) to create subject specific models for precise calibration of individual stimulation patterns.

Project Mentor: Musa Audu, Biomedical Engineering

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The Usability and Efficacy of Elevate: an Application for Stress and Mood

Grace O'Brien, Economics

In addition to regular sessions with a therapist, individuals with anxiety, depressive, or mood disorders are often given supplemental therapy to be completed between sessions to reinforce the skills learned in therapy. Interactive computer software can be a better supplement when compared to traditional cognitive behavioral therapy. However, technology is moving towards a more flexible, fast-paced, and mobile platform. Elevate is an interactive application that incorporates traditional cognitive behavioral therapies, soon to be available on all mobile devices. Therapies within the app include cognitive restructuring, relaxation techniques, self-monitoring, and a rewards system. By downloading Elevate, patients will no longer be restricted to a computer desktop and can simply open the application in their smartphone or tablet. The objective of the initial project is to develop a portion of the back-end, website aspect of the application, specifically the "Learn" tab. This component of the app is a reference section, with resources on how to properly conduct diaphragmatic breathing and cognitive techniques. Eventually, a sampling of individuals within the target age range of 18-25 will be surveyed on their perception of the user-friendliness and accessibility of the completed "Learn" tab of Elevate's website. The results of the survey will then be used in the development of the mobile app. The use of this app will ideally teach users how to effectively manage their emotions and ultimately, decrease their stress and anxiety levels. The next step will be to share the app with therapists so that patients with actual diagnoses can benefit from Elevate.

Project Mentor: Amy Przeworski, Psychological Sciences

Towards understanding the role of retinol transport in vitamin A homeostasis

Ki Oh, Biochemistry

Vitamin A distribution is crucial for maintaining retinoid homeostasis in peripheral tissues and supporting proper vision. In serum, vitamin A binds to the retinol binding protein RBP4. Vitamin A from its RBP4 bound form passes into tissue mediated by a membrane receptor encoded by the stimulated by retinoic acid gene (STRA6). Though STRA6 is a recent discovery with many questions remaining, our laboratory has characterized a few of its physiological functions using animal models and cell culture. The present studies examine how Stra6 contributes to vitamin A homeostasis under variable dietary conditions of vitamin A. Thus, we subjected STRA6-deficeint (ko) and heterozygous (het) siblings to different dietary interventions. In ko mice, ocular retinoid content was significantly reduced as compared controls. This reduction was most pronounced under dietary vitamin A deprivation. Accordingly, we found notable differences in retinal structure through optical coherence tomography: the photoreceptor layer was absent in vitamin A deprived ko mice. In contrast, Het siblings maintained ocular vitamin A homeostasis and photoreceptor cells all diet conditions. Retinoid levels also varied significantly in the testes. Similar to the eyes, STRA6 is highly expressed in epithelial cells of this organ. Thus, vitamin A content of this organ was significantly lower in ko mice. As previously established, vitamin A deficiency affects spermatogenesis. To confirm this observation in mice, mRNA and protein expression levels were compared and indeed significant variations of retinoid responsive genes were observed in ko mice. Lastly, the choroid plexus is known to express STRA6, serving as a gateway for vitamin A transport into the brain. Current work revolves around investigating the impact of impaired vitamin A transport on brain health and function. Together, our analyses provide clear evidence that STRA6 helps to maintain vitamin A homeostasis in tissues such as the eyes and testis

Silencing Melanoma Differentiation-Associated Gene-9 Regulates Growth of Breast Cancer Cells

Davina Oke, Biology

Background: Breast cancer is the most frequently diagnosed as well as the leading cause of cancer-related deaths in women worldwide. An estimated 231,840 new diagnoses of invasive breast cancer are expected in women in the U.S. in 2015. This disease is characterized by dysregulated growth of tumor cells, allowing for metastasis to distant organs, which is what ultimately kills breast cancer patients. Metastasis is a multistep cascade of events, which involves the ability of tumor cells to i) locally invade through basement membrane, ii) intravasate into nearby blood and lymph vessels, iii) survive in circulation, iv) extravasate at a distant metastatic site, v) colonize and grow at the metastatic site. Importantly, outgrowth of metastatic lesions represents the rate-limiting step of the metastatic cascade. Melanoma differentiation-associated gene-9 (MDA-9) is an important regulator of proliferation and tumor invasion; understanding its effects on breast cancer progression would aid in battling breast cancer.

Materials and Methods: Immunofluorescence was used to visualize MDA-9 localization in NMuMG cells. NMuMG and D2.A1 cells were depleted of MDA-9 protein expression via lentiviral transduction of two MDA-9 shRNA constructs, targeting distinct sites on the MDA-9 mRNA. Western blot analysis was utilized to monitor protein expression in MDA-9 depleted cells. Parental and MDA-9 deficient D2.A1 cells were cultured using 3D organotypic culture system to mimic the elastic modulus of breast and lung tissues. Mice were engrafted with MDA-9 depleted cells and primary tumor growth was monitored using bioluminescence imaging.

Results: MDA-9 localized to mitotic spindles in NMuMG cells. Importantly, downregulation and silencing of MDA-9 resulted in elevated ?1 integrin expression in NMuMG cells. MDA-9 depletion inhibited the growth of D2.A1 cells in 3D culture. Lastly, MDA-9 deficiency did not significantly alter D2.A1 primary tumor burden in comparison to the control group.

Project Mentor: Dr. Rebecca Benard, Biology

Ventral striatal - Amygdalar Connectivity By Neurons Expressing the Dopamine 3 Receptor

Kavya Pai, Applied Mathematics and Biology

The amygdala is a brain structure essential for emotions and defects in the amygdala and its associated nuclei are implicated in several affective spectrum disorders including schizophrenia, bipolar disorder, and posttraumatic stress disorder. Major questions remain regarding how the amygdala interacts with other structures to integrate sensory information into emotional responses. Clusters of granule cells within the ventral striatum (VS) called the Islands of Calleja (IC) are known to project to the amygdala where they may relay or modulate sensory processing. Here, we provide an analysis of a microcircuit from the IC to the posterolateral cortical amygdaloid nucleus (PLCo), including assessing the genetic identity of cells projecting between these two structures. To accomplish this, we unilaterally injected an adeno-associated viral vector AAV9-flex-GFP in male mice expressing Cre-recombinase in their IC to selectively label cells in the IC with green fluorescent protein. This method revealed putative dopaminergic connectivity between the IC and the PLCo. Further, we found preliminary evidence for reciprocal connectivity between the structures, suggesting that not only may the IC modulate the PLCo, but the PLCo may in some instances impact information processing in the VS. Therefore, the present results provide a novel anatomical map of the genetic makeup of cells in this microcircuit that links the olfactory system to the limbic system in rodents. This rodent model can potentially provide insights into the development of affective spectrum disorders in humans.

Project Mentor: Daniel Wesson, Neurosciences

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Preventing Cancer: the Mediterranean diet

Si-Eun Park, Biology

There has been extensive research on cancer preventive diets, with focus on the role of various fruits and vegetables in cancer prevention. Recently, across many biological fields, evidence has accumulated indicating that a Mediterranean diet accompanies reduced risk of cancers. Inspired by traditional diets in Greece, Italy and Spain, the Mediterranean diet usually includes lots of fiber-containing foods (vegetables and fruits) and vegetable oil as the source of fat. This pattern of diet has been proven to decrease the risk of having breast cancer, colorectal cancer, gastric cancer and lung cancer. The researchers have ascribed the beneficial effects of the Mediterranean diet to its high content of specific fatty acids and antioxidants.

Project Mentor: Susan Burden-Gulley, Biology

Upregulation with Hypoxic Pathways (Angiogenic Markers) in Diet-Induced Ketotic Rodents

Aakaash Patel, College Prep; **Prithvi Pendekanti**, College Prep

The brain is considered to have many physiologic adaptations when it is exposed to an oxygen deprived environment. These same adaptations are being studied with ketogenic diets. The diet forces the body to burn fats into fatty acids and ketone bodies. Ketone bodies then pass into the brain and are used as a source of energy. Ketones have been used to treat patients with epilepsy and are currently being studied to treat patients with Alzheimer's disease; however, it is still not understood why ketones are neuroprotective. The body's physiologic adaptations to hypoxia could be directly related to the body's responses to a ketogenic diet because both instances are types of responses to a deprivation of glucose in metabolism pathways. During a variety of western blots and immunohistochemical staining, levels of erythropoietin (EPO), Hypoxia-inducible factor-1? (HIF-1?), and glucose transporter-1 (GLUT-1) were tested for and compared between hypoxia and ketogenic diet. If the adaptations of both hypoxia and ketogenic diets are proven similar, there will be a better understanding of the neuroprotective qualities of ketones, and this knowledge will be used to study further treatments of neurological disorders and neurodegenerative conditions.

In low oxygen environments, EPO levels increase to increase the levels of red blood cells to keep up with capillary reconstruction that occurs at the onset of hypoxia. HIF-1?, a transcription factor, activates over 50 different genes involving different adaptations to this hypobaric environment. GLUT-1 transporters are also upregulated in endothelial cells to accommodate for more glucose intake by the cell through the duration that the cells are exposed to hypoxia. The purpose of this study is to show that if HIF-1?, EPO, and GLUT-1 can be shown to increase during ketogenic diets, then there will be supporting evidence that the adaptations to hypoxia are similar to those of ketogenic diets.

Project Mentor: Kui Xu, Physiology & Biophysics

Radiomic Descriptors to Distinguish Prolonged Survival Characteristics in Glioblastoma Multiforme Patients on Treatment-naïve Multi-Parametric MRI

Jay Patel, Biomedical Engineering

The goal of this project is to determine the prognostic value of radiomics (computerized extraction of features from radiographic images using computer vision and image processing that may not be visually discernible by human inspection) on magnetic resonance imaging (MRI) in distinguishing between short-term survival (STS) and long-term survival (LTS) in Glioblastoma Multiforme (GBM) patients. Despite aggressive modern treatment options including chemotherapy and radiation therapy, the median survival time after initial diagnosis for GBM is only 12 months, with less than 5-10% surviving for over 3 years post diagnosis. Unfortunately, very little is known as to why certain group of individuals exhibit differing overall survival times from majority who have poor survival (STS vs. LTS). Due to this lack in understanding, most GBM patients are currently prescribed a "one-does fits all" type of treatment. Although MRI is the standard-of-care, currently there do not exist any imaging based markers to distinguish STS and LTS. There is hence a clear need to identify quantitative imaging based markers to accurately distinguish patients with STS and LTS so a more personalized therapy decision can be optimized for GBM patients. Over the last few years, radiomics has shown promise in identifying sub-visual features that are not optically discernible on imaging for a variety of clinical applications. In the presented project, we will utilize a variety of radiomic features that capture hidden patterns on multi-parametric MRI (Gadolinium-contrast T1-w (Gd-T1), T2-w, and FLAIR) to reliably distinguish patients with prolonged survival from patients with short-term survival. Quantitative analysis shows that Haralick texture features, which quantify structural and tumoral heterogeneity, can discriminate between STS and LTS on multi-parametric MRI.

Project Mentor: Pallavi Tiwari, Biomedical Engineering

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Study of Extinction Efficiency Enhancement from Localized Plasmon in Light-Emitting Diodes

Eric Pearce-Smith, Electrical Engineering

Arrayed patterns of metallic nanoparticles on the surface of light-emitting diodes (LEDs) are used to couple their surface plasmon resonance with the active region of LEDs in order to improve its quantum efficiency. The light extinction responses to the metallic nanoparticle localized plasmon for different structures have been studied, and trends have been analyzed between the extinction efficiency and wavelength of the light produced for a variety of geometric variables. This study first explores geometric trends with the light extinction response among different structures of metallic cylindrical nanoparticles, and then among a novel nanoparticle structure resembling the volume between an empty, close-packed, hexagonal grid of cylindrical holes. Wavelength-scale simulations in Lumerical's Finite Difference Time-Domain software were used to analyze the light extinction response for the variety of nanoparticle structures. The novel shape exhibits higher extinction efficiency and a wider emission spectra as compared to the cylindrical nanoparticle structure, and could lead to performance improvement in LEDs.

Project Mentor: Hongping Zhao, Electrical Engineering and Computer Science

Peanut Protein Detecting Device

Aryn Pecoraro, Candidate for Bachelors in Science and Nursing, Frances Payne Bolton School of Nursing; **Jesse Honsky**, Frances Payne Bolton School of Nursing; Dr. Colin Drummond, Department of Biomedical Engineering; **Nikita Agrawal**, Department of Biomedical Engineering; **Alexander Bergsneider**, Department of Biomedical Engineering; **Hongfa Jiang**, Department of Biomedical Engineering; **Daniel Schapira**, Department of Biomedical Engineering; and **Bryan Wey**, Department of Biomedical Engineering

The peanut allergy is one of the most common food allergies and can range from mild to severe symptoms, including mortality. An allergic reaction, such as the reaction to the peanut protein through both ingestion and inhalation, occurs when the body's immune system produces an unusually large amount of immunoglobulin E (IgE) antibodies to fight the allergen by releasing certain chemicals. This particular food allergy is on the rise in children. Between the years 1997 and 2008, the allergy more than tripled its prevalence in children of the United States. Through collaboration between Case Western Reserve University biomedical engineering students and a senior nursing student, the goal of the project was to produce a product that would detect the presence of the peanut protein for individuals with the peanut allergy in order to decrease their risk for a reaction.

Project Mentors: Jesse Honsky, Frances Payne Bolton School of Nursing; Dr. Colin Drummond, Department of Biomedical Engineering

Project Mentor: Diana Morris, Nursing

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Necessary Fraud: The Story of Two Cunning Eurasian Brothers and Negotiating Racial Hierarchy

Saadia Pervaiz, biology and history;

This presentation describes a fascinating nineteenth century case of fraud, where two Anglo-Indian orphaned siblings, named Deer and John Christian, posed as Muslim noblemen to fool British officers of the East India Company and obtained hefty loans. Using sources such as correspondences between East India Company officers from the India Office Records of the British Library, I argue that the brothers exploited British fascination with Indian courtly culture to negotiate their place in colonial India's racial hierarchy at a time when avenues for social mobility were being restricted for Anglo-Indians (racially mixed offspring born of European and "native" unions). I examine the duo's motive for committing fraud by locating the story of the two brothers in the larger context of new kinds of legislation and educational institutions that impacted the lives and career prospects of Anglo-Indians. Overall, my paper is an attempt to understand how laws and educational institutions were constructing new kinds of racial boundaries and new attitudes to mixed-race offspring in nineteenth century British India.

Project Mentor: Ananya Dasgupta, History

Image Analysis of PFO-based Organic LED Degradation

Kelly Peterson, Chemistry

Replacing incandescent and fluorescent lights with light-emitting diodes (LEDs) is predicted to significantly reduce lighting energy consumption in the United States. Organic LEDs (OLEDs), which use small molecules or polymers as an active material, have further advantages over LEDs. They use compounds made of more plentiful elements and have the potential to be cheaply produced on flexible materials. Although OLEDs are currently used in some cell phones and televisions, they still have many degradation and lifetime issues that prevent them from being used in lighting and other applications. Blue-emitting OLED compounds, in particular, are known to be less stable than compounds of other colors. OLED devices using a layer of the blue-emitting polymer poly(9,9-dioctyl-2,7-fluorene) (PFO) between two electrodes were made, helping to establish an OLED fabrication process in the MORE Center. The devices were operated at a constant voltage in air, and images of the devices' light emission were taken. The light emission images show changes in device brightness over time. These images were analyzed with R statistics software using scripts developed in the SDLE Center. These scripts characterize the devices' degradation by quantifying changes in their light emission. Correlated with confocal Raman microscopy, this analysis can also yield insights into the chemical degradation pathways of PFO devices. Understanding modes of OLED degradation is critical to research in improving their lifetime and stability for commercial applications.

Project Mentor: Emily Pentzer, Chemistry

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Crowdsourcing in Epidemiology: Current Utilities, Trends and Standards

Katie Pezzot, Statistics, Computer Science

Crowdsourcing has increasingly become an important method to rapidly amass huge amounts of information for scientific research. Epidemiological studies serve as the cornerstone of public health with research areas ranging from identification of important disease etiology, transmission, to outbreak investigation. Therefore crowdsourcing in epidemiology has become a compelling method for scientific discovery. However, there are unique challenges for crowdsourcing in epidemiology in design, data safety, and quality control. Furthermore the crowdsourcing terminology has not been standardized, leading to a large amount of variation in descriptions of crowdsourcing methods.

In this work, we developed a text classification framework with Java. The framework uses a Support Vector Machine (SVM) approach to query Medline articles to analyze the trend of research in epidemiology in the area of crowdsourcing. We identified four main utilities of crowdsourcing in epidemiology: 1) task completion, 2) data mining social media, 3) survey taking from online recruitment, and 4) quality control. We proposed some quality control guidelines for crowdsourcing and concluded with challenges and areas that need improvement

Project Mentor: Jiayang Sun, Biostatistics and Epidemiology

Agency and Violence against Women in Mexico and Brazil

Anna Pickard, Anthropology

This paper seeks to describe the experiences of violence of women in Mexico and Brazil and also describe the ways that they overcome this violence. Mexico and Brazil are the two most populous countries in Latin America, together accounting for a little more than 50% of the population of Latin America. While this does not mean that the experiences of women in Mexico and Brazil are representative of all women in Latin America, it does mean that they are representative of the experiences of many women in Latin America.

The literature suggest that women in Mexico and Brazil, although routinely referred to as "victims" in the literature, would be more accurately characterized as "survivors" because they display agency. Agency can be defined as the ability to make free choices. Agency is often limited by structures, which can be material, like the economy, or cultural, like norms or laws. Calling the women who experience violence "victims" in news, popular media and anthropological research furthers their victimization. However, it is also important to recognize the suffering of these women through scholarship; ignoring their plight is another form of victimization. The types of violence I will be exploring are sex trafficking, rape and sexual assault, and intimate partner violence.

Project Mentor: Katia Almeida, Anthropology

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Coming Out: Self-Esteem and Sexual Identity Distress as Predictors of LGBQ Individuals' Level of Sexual Identity Disclosure

Lauren Pohl, Psychology

Much research exists in the literature examining the outcomes and consequences of lesbian, gay, bisexual, and queer (LGBQ) individuals' decisions to disclose their sexual identity to others. What are less often examined are the factors that promote sexual identity disclosure. Such a line of research has undergone little empirical investigation; however early works have linked positive self-esteem to higher levels of sexual identity disclosure. The purpose of this study was to examine the effect self-esteem and sexual identity distress have on LGBQ individuals' level of disclosure to family members, friends, coworkers or classmates, authority figures (i.e. professors, bosses), and neighbors. The association between LGBQ individuals' (N = 234) self-reported scores of self-esteem (M = 30.65; SD = 7.20) and sexual identity distress (M = 14.79; SD = 6.24) and level of sexual identity disclosure (M = 16.67; SD = 9.46) was examined by means of a multiple linear regression. Both self-esteem and sexual identity distress were found to be significantly associated with sexual identity disclosure (p < 0.001). Self-esteem was found to account for approximately 7% of the variance in LGBQ individuals' sexual identity disclosure, while sexual identity distress was found to account for roughly 22% of the variance. The findings suggest that clinicians should attempt to implement practices that promote increased self-esteem in their LGBQ clients, while also focusing on resolving discrepancies in clients' identity concepts, as to reduce levels of sexual identity distress. Promoting positive changes in these two factors may help LGBQ clients disclose their sexual identity to others.

Project Mentor: Amy Przeworski, Psychological Sciences

Dependence of Squirrel Gait Patterns on Velocity and Terrain

Annie Qiu, Biology and Anthropology

Outside of knowledge gathered from hunting patterns, little is known about squirrel movement patterns. With the high abundance of both Eastern Gray Squirrels (Sciurus carolinensis) and snow in Cleveland, these squirrels must move in the most efficient manner possible in both snow and cement terrain. Since mammals vary movement patterns to adapt to their environmental settings, I predicted that the presence of snow would affect gait patterns, which would in turn affect movement speed. Using a high-speed video capture camera, and frame-by-frame analysis through WinAnalyze, we were able to form gait patterns associated with velocity ranges in both snow and cement terrain. Through analysis of graphs formed in Origin using the gait pattern data, we found that the gait relation between the fore limbs and the hind limbs shifted at two separate velocities when analyzing gait patterns on cement. Preliminary analysis suggests that the first shift at about 0.152 m/s, is correlated with a change from staggered quadrupedal movement – which we classified as walking – to paired quadrupedal movement. This latter quadrupedal movement is described as a hopping gait and defined as the conjoined movement of the fore limbs as a single entity, and the hind limbs as another. The suggested second shift at about 0.508 m/s, is correlated with a change in the paired quadrupedal movement aforementioned. At velocities above the second shift, when the fore and hind limbs are at their closest distance to each other, the fore limbs leave the ground before the hind limbs make contact with the found. In addition, substrate appeared to affect gait patterns. The variation in paired quadrupedal movement was found to only be present on cement terrain. In snow, the squirrels appeared to use exclusively the hopping gait as described before the second shift, even when the traveling velocity surpassed that of the second shift.

Project Mentor: Dr. Roy E. Ritzmann, Biology

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Engineering a MGMT mutation in hematopoietic cells with the CRISPR/Cas system to confer resistance to high dose chemotherapy

William Qu, Biochemistry

Temozolomide (TMZ) is a DNA-alkylating chemotherapeutic drug used to treat glioblastomas. Because the O6-methylguanine DNA methyltransferase (MGMT) gene codes an enzyme that repairs alkylation, O6-benzylguanine (BG) is applied with TMZ in order to inactivate the MGMT gene in tumor cells to achieve better cytotoxicity. However, BG is indiscriminate and can inhibit MGMT in normal cell types as well, particularly hematopoietic stem cells (HSCs). To minimize the side effects of BG/TMZ treatment on HSCs, a site-specific single codon mutation (P140K) can be generated in the MGMT gene with clustered regularly interspaced short palindromic repeats (CRISPR) and CRISPR-associated (Cas) proteins. Experimentation has been conducted in human embryonic stem (H7) cells as proof-of-concept. H7 cells were transfected with Cas9 (a Cas protein), a site-specific guide RNA, and a donor sequence and treated with 10 ?M BG and 400 ?M TMZ. Surviving colonies were then Sanger sequenced. 70% of these colonies showed the P140K mutation in at least one allele, of which 28.5% had the P140K mutation in both alleles. All sequence-confirmed mutated colonies survived additional rounds of drug selection. Future experimentation aims to produce similar results in HSCs and to pursue in vivo testing in mice.

Project Mentor: Paul Tesar, Genetics and Genomic Sciences

The Cultural Immersion Experience: Affective Profiles of University Students Studying Abroad In India

Lisa Richey, Psychology

The research aims to gain insight into the experiential affective profile of short-term study abroad students traveling to India using affect (emotions) as an indicator of acculturation (adjustment to the shock of being immersed in a new culture). This profile is created by investigating surveyed participant affective states over the course of the trip in relation to the Lysgaard (1955) U-curve Stage Model of Cultural Adjustment. The majority of research supporting this theoretical model has been conducted with students studying abroad for a semester or more. This research seeks to address the gap in the literature of how this theoretical model relates to short-term experiences abroad. This study includes four points of data collection: one before the group departed to India (Pre-trip) and three while in India (Intra-trip). Pre-trip data collection includes measuring pre-trip baseline affective state with Watson and Clark's (1999) Positive and Negative Affect Schedule (PANAS-X), predicting acculturation success via the variables of cultural openness and empathy using Van der Zee and Van Oudenhoven's (2000) Multicultural Personality Questionnaire (MPQ), and collecting basic demographic information including information about previous experiences abroad. Intra-trip data collection includes administering the PANAS-X over three different points, including a related extended response survey on the last time point. Thus far the study has been IRB approved and implemented. It is currently in the data analysis stage using JMP software.

Project Mentor: Kathryn Rothenberg PhD, Communication Science/Psychological Sciences

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Comparative Analysis of the Education Systems in Peru and the Philippines from a Global Perspective

Estrellita Romero, Anthropology/International Studies;

The ultimate goal of this project is to investigate the possible impacts of globalization on the educational systems in developing countries, pertaining specifically to educational programs and curriculum. In order to reach this goal I will conduct a comparative analysis of the educational systems of two developing countries, Peru and The Philippines, in order to identify similarities and differences regarding a potential impact of global processes. I will also investigate how the current state of education in each country affects its socioeconomic development and its relation to the rest of the world.

Project Mentor: Katia Almeida, Anthropology

Health Policy: An Understanding of European Health Policy and Comparison to U.S. Health Policy

Sylvan Ryder, Nursing; **Tony Lybarger**, Nursing; **Megan Novak**, Nursing

This study examines health policies related to three major health topics in several countries of the European Union. Comparisons are made with similar policies in the United States.

1.) There have been recommendations in the EU with regards to colorectal cancer screening as of 2003. Since CRC is one of the most prevalent death causing cancers, adequate screening is necessary. A comparison of Sweden and Poland's health policy due to the differences in cancer survival between the two countries based on the research question: How the European commission's objective of "fostering good health in an ageing Europe" is implemented with regards to Poland and Sweden's colorectal cancer screening process

2.) Alzheimer's, which is a neurogenitive disease, is a growing problem in Europe and the USA as the population ages. The EU is making strides in Alzheimer's policy and prevention however, still has a lot to do. There is no cure for Alzheimer's however, it can be treated and progression slowed which is easiest to do if it is diagnosed early. Many signs and symptoms are often missed by family and friends and often it is diagnosed late. The research question regarding Alzheimer's is: What actions have been taken against Alzheimer's in the EU, specifically Poland and the Netherlands?

3.) Electronic Health, better known as E-Health is a growing field in health care systems aiming to help productivity and efficiency. One specific area of E-Health looked at in this review is Electronic Patient Records (EPRs). The countries of Germany and The Netherlands were examined under the research question: How far has the Strategy: Together for Health 2008-2013 facilitated the implementation of Electronic Patient Records in Germany and the Netherlands?

Project Mentor: Cheryl Killion, Nursing

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Differences between central gland and peripheral zone prostate tumors on MRI.

Akash Salgia, College prep

Prostate cancer is diagnosed by radiologists on prostate MRI. There is observational evidence suggesting that prostate cancer looks different on MRI depending where it is located in the prostate. This may lead to misdiagnosis. The objective of this project was to determine differences between central gland (CG) and peripheral zone (PZ) prostate tumors on MRI. Our data consisted of 42 patients with biopsy-confirmed prostate cancer, including some with CG and others with PZ tumors. MRI was acquired prior to radical prostatectomy. After radical prostatectomy, the cancer region was annotated by a pathologist on the histologic slides. T2-weighted MRI and histology were registered via deformable registration in order to map the cancer's extent to MRI. Features were extracted from every cancerous voxel on T2-weighted MRI using Matlab. These features included local entropy, standard deviation, and intensity range. Finally, we will apply the t-test to determine whether CG and PZ tumors share the same characteristics. In the future, this project can help to differentiate CG and PZ tumors and aid radiologists in detecting both CG and PZ tumors.

Project Mentor: Shoshana Ginsburg, Engineering

The Culture of Dentistry

Zoya Sandhu, Medical Anthropology

Dental care has a large impact on the physical and mental health of an individual. In the United States there is a culture of dentistry; phrases such as "brushing your teeth" or "going to the dentist" exist in everyday vocabulary. Yet, there are a variety of factors that influence access to quality care and professional dental services for many Americans. How do access to dental care and the willingness to seek care vary in neighborhoods with different levels of socioeconomic status? How does the education of parents, children, and community members affect preventative dental care? Applying sociocultural anthropology, which is the study of how people make sense of the world around them combined with the relationships among persons and groups, with medical anthropology, which is the study of human health and disease, health care systems, and bio-cultural adaptation, can help to gain a better understanding of how and why these barriers occur. This literature review aims to analyze these issues and posit a way to help bridge this gap in care by considering the anthropological factors affecting dental care in the United States.

Project Mentor: Lee Hoffer, Anthropology

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Using Bioinformatics and Citizen Science to Understand the Role of the Human Microbiome in Colorectal Cancer

Thenessa Savitsky, Biology and Sociology

With rapidly increasing data and knowledge of the human microbiome, we are discovering that the microbes in our gut and their interactions with other microbes throughout the body serve vital functions related to many aspects of our health. We are beginning to better understand the relationships between these microbes, as well as those we encounter in the environment and in the food we eat. More recently, strong links found between microbial activity and carcinogenesis suggest that the composition of the microbiome plays a role in the onset and development of colorectal cancer, and that the nature of this role is heavily influenced by diet. In my research, I explore how our gut microbes interact in relation to diet to understand how certain gut microbial environments become conducive to colorectal cancer. I also focus on the next generation sequencing and bioinformatics tools and techniques that can be useful for identifying and characterizing the microbes/microbial environment that promotes carcinogenesis. Microbiomics and bioinformatics methods, especially in the context of open access and citizen science, hold great potential for identifying biomarkers for colorectal cancer and provide options for in silico diagnosis and treatment.

Project Mentor: Dianne Kube, Biology

Hand Hygiene for Preschoolers in Waianae, Hawaii

Joanna Schell, Nursing; **Patrick O'Day**, Nursing

Hand hygiene is known as the most effective technique to reduce the spread of communicable diseases. The preschool age group, ages 3-5, is at high risk for transmitting diseases due to lack of knowledge and unhealthy tendencies of young children. Waianae, Hawaii is an area both geographically and financially removed from the wealthier areas of Hawaii, such as Honolulu. The Ark of Safety is a Christian academy in Waianae that focuses on providing opportunities amidst this less fortunate community. This project focuses on hand hygiene in children, aged 3-5, from the Ark of Safety. A pretest was conducted with 30 children to determine their hand washing techniques at baseline. Six age appropriate lessons were provided over 13 weeks. The hand washing sessions took place over 20 minutes, followed by a weekly lesson on relevant health topics. A posttest was conducted at the end of the 13 weeks to evaluate the effectiveness of the training. The expected results are that the children will score higher on the hand washing posttest, indicating a successful intervention. It is hoped that the project will decrease the probability of transmission of communicable diseases. This project may be sustained through the children's interactions with family members in the home setting as well as the continuation of the program with the next group of HPU students.

Project Mentor: Patricia McDonald, Nursing

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Abstract: Forming Black Adolescent Identity: A Review

Imani Scruggs, psychology

This review will focus on the well-documented struggles that have continuously plagued the minds and spirits of black, male adolescents across the United States. Through examining extensive research on racial socialization practices through the perspective of ecological theory, this essay will assess the different means by which the environment affects the development of young, black males. The author will not only review the history behind the attitudes attributed to black males, but will additionally describe the detrimental effects that this has on the population. The review will also consider the outcomes, both positive and negative, that come along with various community resources such as religious institutions, and further examine the impact of active role modeling in the boys' lives. The author will conclude with giving examples of intervention opportunities that are already available, as well as discussing the potential implications that this set of compiled data has on the aforementioned interventions.

Project Mentor: Sharon Milligan, MSSA degree

Metastatic Basal Cell Carcinoma

Jacqueline Selph, Medicine

Despite being the most common cancer in the United States, basal cell carcinoma with metastasis is extremely rare. The majority of the primary sites involve the head and neck, and the most common sites of metastasis in descending order are the regional lymph nodes, lung, bone, and skin. We present a case of a patient with a history of multiple basal cell carcinomas who presented with likely lung metastasis. Confirmation of metastatic disease was made through histopathological correlation of lung tissue with prior basal cell carcinomas. Patient underwent wedge resection of lung metastasis with no further treatment recommended.

Project Mentor: Meg Gerstenblith, Dermatology

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Locomotion Comparison between Humans and Quadrupedal Monkeys

Doun Seo, Biology

Because some primates habitually utilize both bipedal and quadrupedal locomotion, they have been a point of reference for understanding the evolution of bipedal locomotion in humans. Contrary to popular belief, previous studies have suggested that bipedalism is not more economical than quadrupedalism based on similar metabolic cost such as similar oxygen consumption level (Pontzer et al., 2014). Instead, gait mechanics could be the determinant of the cost. More extended posture and stiff-legged gait of bipedalism would tend to decrease this cost by improving reliability and efficiency in maintaining balance. Therefore, I am testing the hypothesis that the fundamental difference between bipedal and quadrupedal locomotion would lie in the analysis of trunk and hip joint angles. I used high-speed video (120 fps) of monkeys in walking locomotion, including mandrill and black spider monkey, and of humans in walking and running locomotion. The videos were taken at the Cleveland Metroparks Zoo then analyzed and compared with video from human walking using slow motion analysis software (WinAnalyze). Aspects of various joint angles including those of ankle, knee, hip, thigh, arm, elbow, and trunk, and gait and stride frequencies were measured and compared. Preliminary analysis does indicate that notable differences include hip and trunk angles which may reflect the upright posture during bipedalism. In addition, higher stride frequencies as well as shorter step lengths were observed during bipedalism. Further analysis may also suggest the influence of degree of arboreality in the results as mandrills are relatively more terrestrial compared to black spider monkeys. This will help clarify the relationship between locomotor anatomy and mechanics and provide insight to evolution of development of bipedalism.

Project Mentor: Roy Ritzmann, Biology

Sediment mass and nutrient accumulation rates in Lake Erie using Geographic Information System (GIS)

Jinyu Seo, Environmental Geology

This study emphasizes the reconstruction of sediment deposition rates and sediment concentrations of nutrients and nutrient fluxes in Lake Erie through the creation of geological maps using Geographic Information System (GIS). Sedimentation rates, nutrient sediment concentrations and nutrient flux data from Lake Erie were collected from a variety of sources and used to generate contour maps of the sediment deposition rates, nutrient concentrations and nutrient fluxes. These maps are helpful in determining post-depositional sediment focusing and internal cycling of nutrients in the lake.

Project Mentor: Gerald Matisoff, Earth, Environmental, and Planetary

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Model of Arm Movement by Estimation of Intended Equilibrium Posture and Relationship to Electromyograms

Samir Shah, Physics

Neural damage as a result of stroke or spinal cord injury often results in impaired range or movement and reduced capacity to move and manipulate objects. For individuals with retained partial voluntary control, intent augmentation may serve as a means of restoring function after neuromotor injury. To evaluate the feasibility of such a system, this project aims to estimate the arm movement intent of healthy individuals as the desired equilibrium point (EP) of the arm from the limb's position, segment orientation, and electromyographic (EMG) signals of the muscles of the shoulder and arm.

The EP is defined as the zero-sum of active muscle forces arising from neural excitation of muscles, passive forces including viscoelastic properties of the biological system and gravity, inertial forces due to acceleration of limb segments, and external forces resulting from contact of the limb with the environment. A mechanical model will be created that calculates the current EP of able-bodied participants as they perform a series of abstract and functional tasks. The resulting current EP data from this model will be used as the training target for an artificial neural network using EMG signals and arm orientation and position as inputs. The input EMG signals, collected from previous work on this study, will serve as an indication of force-intent.

When coupling the EMG signals with the location and orientation data, a virtual, intended EP can be calculated. Therefore, it is hypothesized that a significant, non-linear relationship between arm position, segment orientation, and EMG to the participant's desired arm EP can be determined. The viability of this approach to determining user intent can later be expanded to individuals with impaired neuromotor capacity to provide an intuitive user interface to a functional restorative device.

Project Mentor: Dr. Matthew Williams, Biomedical Engineering

Air Pollution in China: Education for a High Risk Population

Nicole Shelton, nursing; **Johanna Lam**, Nursing

Long-term exposure to ambient (outdoor) air pollution (AAP) is associated with increased risk of cardiovascular and cerebrovascular disease. AAP effects on health caused 3.7 million deaths worldwide in 2012. The World Health Organization (WHO) provided an Air Quality Guideline to monitor pollutants such as particulate matter (PM), and The People's Republic of China (PRC) was nine times over the recommended guideline for PM2.5 in 2012; Wuhan, PRC was over the PM2.5 guideline by tenfold. In a survey administered to the 24 residents in the Changhu Senior Center in Wuhan, 54% were unaware of the air quality and its potential effects on health, and none of them wore appropriate masks during heavy pollution. We partnered with the Changhu Senior Center, nursing students and faculty from Wuhan University to provide weekly one-hour educational sessions over three weeks. Various methods were used to teach the effects of AAP on health, minimizing exposure, and appropriate 3M N95 mask application. Attendance from week to week ranged from 22 to 26, and eight people attended all three sessions. A posttest at the end of the last session revealed a 39% increase in knowledge for the eight consistent participants, and by the end of the last lesson, 23 participants were able to apply a 3M N95 mask without assistance. Educational programs about air pollution and N95 mask usage were well received in this community, but more research is needed to see if the air pollution education in this community yielded change in lifestyle choices.

Project Mentor: Deborah Lindell, Nursing

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Functionality of cholesterol efflux transporter ABCA1 in high-grade prostate cancers

Mahi Singh, Biology and Anthropology; **Mahi Singh**, Biology and Anthropology

Previous studies have shown a significant positive correlation between high serum cholesterol levels and prostate cancer aggressiveness. Additionally, it has been observed that statin use actually lowers the risk of advanced prostate cancers. For these convincing reasons, it is interesting to understand the mechanism by which prostate cancer cells manipulate intracellular cholesterol content. This information is important in advancing our understanding prostate cancer, as well as cancer cell biology as a whole.

ABCA1 protein is a cholesterol transporter protein; when this protein is hypermethylated, and thus silenced, there is an increased retention of intracellular cholesterol. Importantly, this epigenetic inactivation of the ABCA1 gene occurs only in intermediate and high-grade prostate cancers, and thus seems to be essential in the progression of the cancer. Preliminary work has shown that approximately 90% of high-grade prostate cancers have no ABCA1 present. Here, we look at the remaining 10% of those samples in order to study the functionality of the ABCA1 protein there. To do this, we extracted and purified DNA from paraffin-embedded high-grade prostate cancer patient tissue samples, PCR amplified the coding region for ABCA1 from the obtained DNA, and analyzed the sequencing results from the PCRs in order to determine whether the existing ABCA1 has normal functionality, or if there are deleterious mutations which prevent the ABCA1 from functioning normally.

Project Mentor: Dr. Dianne Kube, Biology

Bilateral sensory inputs are not created equal: Bilaterality in mechanosensory inputs is more important than olfactory for plume tracking hawkmoths

Alison Smith, Biology&Cognitive Science

Males of the hawkmoth species Manduca sexta are able to track plumes of female pheromone in flight using their olfactory systems, which receive direct input from antennal sensory cells. To do this they use two possible odorant comparison strategies: spatial and temporal. A moth using a spatial strategy compares odor detected on one antenna to that detected on the other, steering accordingly. While those using a temporal strategy compare odor signals detected at sequential points in time. In spatial comparisons, unilateral antennal removal should greatly diminish their ability to locate an odor source. In temporal comparisons, a unilateral antennectomy should have a lesser impact as the moths could still compare odor cues over time. To determine which of these underlies plume tracking, we removed antennae in four ways: (1) surgical removal of an antenna immediately prior to experimentation, (2) surgical removal of the imaginal discs responsible for development of the adult antenna during the last larval stage, (3) surgical restriction of growth of the odor-detecting sensory cells on the antenna in stage 1 pupae while preserving the mechanosensors at the antennal base, and (4) surgical removal of an antenna while preserving mechanosensors at the antennal base immediately prior to experimentation. In the last two treatment groups, a donor antenna was attached to the remaining stump at the antennal base effectively "re-loading" the large mechanoreceptors. Though 95.2% of control moths find the odor source, only 44.7% of acute antennectomies and 23.9% of imaginal disc removals do so. With mechanosensation preserved, the pupal antennectomies locate the odor source 72.5% and the acute antennal reattachments 59.4% of the time. These results show that, while two antennae are ideal for plume tracking, for M. sexta one is sufficient, consistent with using a largely temporal strategy. It also reveals the importance of bilateral antennal mechanosensory inputs for flight control.

Project Mentor: Dr. Mark Willis, Biology

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Analysis and Processing of Hyperspectral Data with the Purpose of Classification

Logan Smith, Math and Physics

Hyperspectral imaging is an advanced imaging technique that measures visible and near-infrared light reflecting off a surface. Hyperspectral imagery has a wide range of applications from geospatial sciences to ecology, surveillance and more. A hyperspectral image is a 3D structure with a spectrum of values associated with every pixel corresponding to the image intensity at a fixed spatial location recorded at different wavelengths. These spectra can be compared to known materials, and then classified.

Hyperspectral data processing has been given a lot of attention during the past decade, but the problem of classification is still open. We intend to perform an in-depth study of the existing classification and dimension reduction methods for hyperspectral data. We will attempt to improve those by integrating the most successful existing methods into a joint framework and/or adjusting the methodology for a specific subclass of data with the goal of improving the performance in either the quality of output or the computational efficiency. We will use the publicly available hyperspectral datasets and spectral signatures (SpecTIR® Remote Sensing Division website, IEEE, NASA).

Project Mentor: Julia Dobrosotskaya, Mathematics

Identifying the role of novel genes in the sterility incompatibility between Drosophila species.

Shelby Snashall, Biology

Speciation occurs as a result of genetic barriers that limit successful reproduction between two species due to hybrid sterility or lethality. Crosses between Drosophila simulans and Drosophila sechellia can produce fertile female hybrids, while Drosophila melanogaster with either D. simulans or D. sechellia always results in infertile hybrid females. This finding is indicative of a common fertility system between D. sechellia and D. simulans, and a more divergent system in D. melanogaster. By searching through around 600 genes that were similar between D. simulans and D. sechellia, but that were different from D. melanogaster, 8 genes were determined to be ideal candidates for the infertility phenotype of D. melanogaster hybrids. These genes were selected due to their exclusive expression in germline cells during steps in which sterility in the hybrid may be generated. Previous work has been done to test the role of one of the candidate genes, CG14545. It was found that females that express RNAi against CG14545 in their germline have progeny with dramatically more daughters than sons. Based on this skewed progeny results, we hypothesized that the PIWI pathway, which is responsible for the silencing of transposition in the germline was disrupted. The increase in mutations would affect predominantly the survival of the hemizygous sex in the progeny. Since males only receive one X chromosome donated by the mother expressing RNAi, males receiving a mutated X chromosome carrying a recessive lethal mutation would die, while their sibling females would survive due to another normal copy of non-affected X chromosome. I previously used the Anti-PIWI antibody to detect potential defects in the protein distribution within nuclei of nurse cells of ovaries expressing RNAi for our candidate gene. We show a decrease of PIWI protein within the nurse cells of mutant ovaries as compared to wildtype ovaries, indicating a disruption in the silencing of transposons. Additional genes and components of the PIWI pathway will be tested to support the above hypothesis.

Project Mentor: Claudia Mizutani, Biology

A Dual pH Sensitive siRNA Delivery System to Efficient Gene Silencing

Dayton Snyder, Biomedical Engineering

Small Interfering RNA drug delivery systems are gaining more attention than ever due to their promise in the fight against cancer through gene silencing. An effective and safe drug delivery system needs a nanoparticle able to overcome many delivery obstacles. The current study aims to enhance the properties a pH sensitive cationic lipid nanoparticle called (1-aminoethyl)iminobis[N-(oleicylcysteinyl-1-amino-ethyl)-propionamide] (ECO) with a polymer, polyethylene glycol (PEG), functionalized with a hydrazone bond and an RGD (arginine-glycine-aspartate) targeting peptide in order to effectively silence a target gene. The PEG decreases the cytotoxicity but it also decreases the endosomal escape and the cellular uptake. The hydrazone bond sheds the PEG once in a cancer cell's endosome to allow proper endosomal escape. The RGD targeting peptide allows the nanoparticle to be readily taken up into the cell. The pH sensitivity of the hydrazone bond and the charge shielding of the PEG was tested using zeta potential analysis. The pH sensitivity and endosomal escape were tested through a hemolysis assay. Flow cytometry was run on nanoparticles in regular and acidic medium to ensure the nanoparticles enhanced cellular uptake was not due to the hydrazone bond cleaving in the acidic tumor environment before entering a cell. A luciferase assay determined the reasoning behind the enhanced gene silencing and the efficiency of gene silencing by the RGD-PEG(HZ)-ECO nanoparticle. It was found that gene silencing efficacy of the nanoparticle was similar to that of an unmodified ECO nanoparticle. The cytotoxicity was determined to be reduced as well. It was also determined that the pH sensitivity of the hydrazone bond was the sole reason behind the increase in efficacy between PEG-ECO nanoparticles and the PEG(HZ)-ECO nanoparticles. Thus, the modified ECO nanoparticle is as efficient as an unmodified nanoparticle but it is safer, which is crucial for incorporation into humans

Project Mentor: Zheng-Rong Lu, Biomedical Engineering

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Children' Rights Protection During the Urbanization and Internal Immigration in China

Danrui Song, Medical Anthropology / International Studies

Children's rights are a major part of universal human rights, which means it is an influential organizing principle for government, development and aid. Therefore, children's rights protection is one of the most essential tasks worldwide. However, it can be very challenging in some developing countries, especially when those developing countries are in the stage of industrialization, leading to urbanization and internal immigration. Because, in this special stage, the state government and the public put most of their attention on the economy, it is natural and easy for them to ignore other things, such as children's rights protection. For example, in China, there are an increasing number of "left-behind" children, whose parents are migrant workers living in cities and who have to raised by other care providers. Those children experience a different childhood than others because a lack of parental care exerts significantly negative impacts on left behind children's lives. In this presentation, I will use the case of China's left behind children to argue that children's rights protection should be emphasized during the countries' industrialization and economic development, because the negative impacts on the left behind children and society at large cannot be ignored. More importantly, based on the case of China's left behind children, I would like to do some research and find some potential solutions to improve this situation.

Project Mentor: Lihong Shi, Anthropology

Improving Parent Education for Non-English Speaking Families in Cork, Ireland

Natalie Southard, Nursing

According to the Irish National Central Statistics Office, there were 72,225 births in Ireland in 2012. Health care professionals have a major role in guiding families to care for new children, as well as providing support and imperative health check ups. The Irish Health Service Executive (HSE) has standards and protocols for their childhood assessments and immunizations. The Irish public health nurses (PHN) are responsible for implementing these important protocols in a variety of settings.

In the last 10 years there has been an influx of non-English speaking immigrants to Ireland. One important challenge for the PHN is the lack of educational materials for parents not proficient in the English language. There are plenty of educational tools for parents created by the HSE, however, few are aimed towards non-English speaking parents or those with low-literacy. This communication barrier makes it difficult for the PHN to properly teach these families about their child's growth and development. To reduce this barrier there was a need to develop suitable materials. In consultation with the PHN, critical content and format for a poster were identified. The poster explains the growth and development of babies from birth to 12 months using simple pictures with no text. It can be used by the PHN during visits with parents and given to the parents to take home. The poster has been displayed at a local health center and will be used as a teaching aide by the PHNs. The materials were well received by the PHNs there.

Project Mentor: Mary Quinn Griffin, Nursing

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Commercial Disc Dyes for 3D Optical Data Storage

Aniya Speed, College Prep

Blu-ray and compact discs are commonly used to store large amounts of information in an easily accessible format [1]. Some use organic dyes for writing, but bits are written by degrading the dye with a high intensity laser, leading to changes in reflection. This is not an ideal method for optical data storage in many layers. However, these same dyes may be exhibit fluorescence and be very stable when exposed to low light levels, which is ideal for many layer storage. Past work has shown that optical data storage using multilayered films and fluorescent dyes can achieve a bit density comparable to Blu-ray, without the layering limitations [2]. I have studied these discs and extracted the dyes from the interior to characterize their potential for use in 3D optical data storage. I peeled the active layer from the two discs and separated the dye using a solvent. The BD dye has a peak in the absorption at about 450nm and below 300nm. The CD has a peaks at about 650nm and 700nm, as it is designed to absorb higher wavelengths. Both dyes also show a weak fluorescence when a blue laser pointer is shown in the dye, suggesting they may be valuable 3D optical data storage.

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Project Mentor: Cory Christenson, MSE

ULTRASOUND BASED NAVIGATION WEARABLE DEVICE

Tyler Srail, Biomedical Engineering; **Swetha Rao**, Biomedical Engineering; **William Meador**, Biomedical Engineering

ULTRASOUND BASED NAVIGATION WEARBLE DEVICE

William Meador, Swetha Rao, Joonsue Lee, Scott Shary, Tyler Srail; Case Western Reserve University
According to the International Classification of Diseases, there are 4 levels of visual function: normal vision, moderate visual impairment, severe visual impairment, and blindness. When the last three levels are grouped together, this creates a pool of visually impaired people in the world. According to the World Health Organization (WHO), about 285 million people worldwide are estimated to be visually impaired, with 39 million being legally blind and 246 million having low vision. With such a large number of people blind worldwide, it is important to focus the target demographic for our device. We have created a device using ultrasound detection to control audio feedback on a wearable device. This device empowers those with impaired vision to navigate independently.

Project Mentor: Colin Drummond, Biomedical Engineering

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Improving the Structural Integrity of Airway Stents By Creating a More Custom Model

Meghna Srikanth, Biomedical Engineering; **Mallory Busso**, Biomedical Engineering; **Connor Edel**, Biomedical Engineering

Stents that are placed in the human lungs to open an airway to increase airflow and increase lung capacity have a short life span. This is due in part to two major problems: (A) material failure, the material is not strong enough to withstand the environment in the lung, and (B) Displacement by a cough due to inadequate size or force of a cough on the stent site. Dr. Colin Drummond of the Department of Biomedical Engineering at Case Western Reserve University in collaboration with the Cleveland Clinic Foundation proposed this project to the team.This project will address the two major concerns with this device by creating a process that will create a more customized stent for the airway. These airway stents are designed through analyzing the CT images at the target area by using the software that will import the CT image and allow the physician to create a more customized stent by creating a computerized stent model that can be configured to be more comfortable for the user before creating the physical stent. Through the software, the physician will be able to modify the stent from the generated model. Once the generated model is imported into SolidWorks, a mold model consisting of two outer mold bodies and a center core was created and then exported to a 3D printer. The mold will be used to construct the silicone stent. The stent will then be coated with Parylene N. In the end, the stent produced will prolong life by reducing the amount of material failure, improving the fit of the stent in the body, reducing the likelihood of infection, and extending the life span of the stent in the body. Therefore, this stent will be able to increase airflow through reinforcing the walls in diseased airways from tumors, metastases, and tracheal and bronchial stenosis.

Project Mentor: Colin Drummond, Biomedical Engineering

Teaching Healthy Habits in Hong Kong

Madeleine Starr, Nursing; **Peter Chen**, Nursing; **Florence Kiang**, Nursing

Promotion of healthy habits is often a factor seen to attribute to lower rates of obesity and ailments related to obesity. This research was aimed to investigate if teaching interventions was a direct contributor in increasing the knowledge of healthy habits among locals of Tseung Kwan O in Hong Kong. The teaching interventions used for promoting healthy habits was broken down into 3 main topics: portion control, the importance of breakfast, and exercise. A non-random sample of 13 locals of various ages were selected and given a pre and post-test survey. After reviewing the responses from the pre and post-test surveys the following observations were made:Of the 10 questions, 4 of the question responses varied significantly. The questions relating to the number of times breakfast eaten each week, hours of exercise each week, and if one knew the correct serving size of a portion of rice all increased in percentage for positive responses, being that the participants had increased frequency of eating breakfast, more hours of exercise, and knowing the correct portion size. A larger percentage of participants saw themselves as non-healthy eaters on the post-test than the pre-test. Overall, the results of the teaching interventions were successful in increasing the level of knowledge locals had on healthy habits, however; it is recommended that interventions are continued as well as increasing the number of participants to allow a random sample to be taken. A larger random sample should reveal the true correlation between teaching interventions and the knowledge of healthy habits among locals of Tseung Kwan O.

Project Mentor: Rita Sfiligoj, Frances Payne Bolton

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Mechanical Behavior of Aerogel with Different Poly (vinyl alcohol) Amounts

Arik Stewart, College Prep

Mechanical Behavior of Aerogel with Different Poly (vinyl alcohol) Amounts

Aerogel is a solid material mostly known for its low density and unique structure. For this project we made Aerogel through a process of mixing clay () with a substance that included normal deionized water with dissolved polyvinyl alcohol (PVOH) then freeze-drying it afterwards. We made four groups of six samples composed of different amounts of PVOH but with the same amount of clay. We later did a compression test for each individual sample. The purpose of it all was to see how the aerogel mechanical properties would behave with the different PVOH amounts. Two groups with the same amount of PVOH were compared with one of them not having any clay. We concluded that the more PVOH included in the sample, the higher the modulus turned out to be. The group without the clay turned out to have a higher modulus.

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Project Mentor: Hua Sun, MSE

Barriers to College Education for Students Who Are Parents

Kayla Stoltz, Medical Anthropology

This poster examines the discrepancies between what it takes to be a successful college student and the realities of being a young parent. This research explores the social and day-to-day complexities of the life of an individual who becomes a parent during their teenage years or very shortly after. These are the people labeled 'teen parents'. The unique difficulties of their lives are examined and compared to what is necessary to be successful in academia. To accomplish this I have utilized academic publications, government publications, ethnographic data, and my own life experiences. The purpose of this study it to focus attention on the often insurmountable difficulties these individuals face when pursuing higher education. Through this study I hope to develop suggestions to help make this path more accessible to these individuals taking into consideration the differing needs of these individuals over more traditional college students.

Project Mentor: Lee Hoffer, Anthropology

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Approaching Resilience: Supporting Children Living in Low-Income and Poverty

Elizabeth Stotter, Psychology

Low-income and poverty creates chronic stress that impacts children and families who experience such hardships. For children specifically, this chronic stress imposes challenges and additional barriers on their developmental outcomes. Children are expected to perform at developmentally appropriate tasks, but economic disadvantage can interfere with their abilities to do so. Their academic achievement may be compromised, as well as their social supports, mental, emotional, and physical health continually. However, some children do not experience these negative outcomes that may have been expected otherwise. Rather, they thrive in the face of adversity. This paper will consider resilience in relation to children living in low-income homes and poverty.

Despite the growing interest in resilience research, there is a lack of consensus as how to define and recognize resilience in individuals moreover. In order to understand how resilience is fostered and manifested in children, it is first fundamental to define this concept. This paper will compile relevant literature related to defining resilience as well as recognize relevant theory to further conceptualize this definition. Continually, attention will be given to internal and external factors that may, arguably, promote resilience. My personal experience in the social work field has enlightened my research by providing me with relevant examples in a school-based setting. I have encountered students who are motivated by their circumstances and/or nature, and others who are not. Ultimately, taking a strength-based approach by focusing on resilience in children could enhance practice and policy targeted at this population.

Project Mentor: Dr. Sharon Milligan, MSSA

Role of Toll-like receptor 9 in a murine model of Crohn's-like ileitis

Christine Straka, Biology

The SAMP1/YitFc (SAMP) mouse strain represents a chronic model of IBD and provides an excellent system to study the contributions made by specific cell types to the development of enteritis, prior to the onset of inflammation, during the initiation and acute phase of inflammation, and when chronic disease is established. Additionally, since SAMP mice were derived from brother-sister mating of WT AKR/J (AKR) mice (parental strain), the phenotype occurs spontaneously as in the human condition, without chemical, genetic, or immunologic manipulation. Although gut microbiota is believed to have a key role in IBD, the comprehensive biochemical pathway is still up for debate. In fact, recent studies report that the commensal microflora, through toll-like receptor (TLR) engagement, can induce intestinal Th17 cells. In particular, TLR9 signaling has been shown to promote the development of a mucosal Th17 effector population, suggesting a role of TLR9 dependent Th17 immune responses in the gut mucosal inflammation. The goal of this study was to evaluate the ileal phenotype in SAMP mice that have been knocked out for TLR9 and evaluate whether the intestinal phenotype is affected by the absence of this receptor. Therefore, we generated SAMPxTLR9 KO mouse, by backcrossing SAMP with TLR9 KO mice, and evaluated ileal inflammation, to clarify if TLR9 plays a detrimental role in intestinal inflammation.

Project Mentor: Theresa Pizarro, Pathology

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Functionalization of Perylene Diimide Tailored for the Formation of Conductive Organic Materials for Photovoltaics

Jordan Swisher, Chemistry

Photovoltaic (PV) devices which harvest solar energy are of great interest to meet the growing need for energy consumption throughout the world. While inorganic PV devices tend to be heavy, cumbersome, and have toxic component, organic PV devices can be light weight, flexible, and non-toxic. Currently, the efficiency of OPV devices is too low to be commercially viable, necessitating optimization of materials and device design. Ideal OPVs are composed small domain (~20 nm) of two materials in intimate contact, although this is hard to achieve due to the inherent desire of the two materials to separate. The work presented here focuses on controlling the size and shape of the material domains, as well as defining the interface between the two. To accomplish this, we use the organic small molecule perylene diimide (PDI) which is ideal for OPVs due to absorption of solar energy and conductance of electrons. Synthetic chemistry is used to asymmetrically functionalize PDI to give different shaped "building blocks" that crystalize into domains, the size of which is dictated by the functionality. Importantly, one branch of the asymmetric functionalizalization contains a reactive handle that can be used to define the interface with a second material. We report the synthesis of a family of molecules with different substituents, evaluation of their crystallization through pi-pi stacking interactions, and the correlation of the functionality with the size and shape of the crystals formed. Ongoing work focuses on utilizing reactive handles on the crystal surface, as well as understanding the electronic properties of these nanomaterials and incorporating them into OPV devices, en route to yield cheap and sustainable solar cells.

Project Mentor: Emily Pentzer, Chemistry

IPSCs as viable treatment for DMD

Michael Takes, Biology

In 2006, Shinya Yamanaka's lab demonstrated that modifying certain factors in adult somatic cells could be used to generate induced pluripotent stem cells (IPSCs). The four genes involved were Oct4, Sox2, Klf4, and c-Myc, and were used to transform mice fibroblasts into cells that were equivalent to embryonic stem cells. Since this discovery, there have been a number of advances in generation efficiency of IPSCs, as well as safety of the transformation, as two of the factors (c-Myc and Klf4) were oncogenic and produced cancer cells in some tissue. This paper will examine some of methods used to generate IPSCs, as well the benefits and shortcomings of each approach. It will also discuss some potential uses of these cells, with a focus on treating Duchene Muscular Dystrophy using CRISPR/Cas9 and TALEN to correct the faulty dystropin gene. Induced Pluripotent Stem Cells show great promise in research since they eliminate the risk of immune rejection for organ transplants or tissue grafts, as well as sidestep the ethical dilemma of using embryonic stem cells. IPSC's also represent a potential source of unlimited cells for research and clinical trials.

Project Mentor: Dianne M. Kube, Biology

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Undergraduate Opinions of History

Catherine Tate, Biology, Cognitive Science

Based in part on a study done by Thelen and Rosenzweig in the 1990s, this study asks the question of what aspects of history do undergraduate students at Case Western Reserve University find most important and engaging. A survey sent out to students asked for responses ranging from the perceived importance of studying history to rankings of how engaging and informative past interactions with history have been. Based on the results, it is clear that despite CWRU's status as a university well-known for science and engineering programs, the study of history is still a subject that is interesting and important to the students here. Going beyond the original Thelen and Rosenzweig study, this survey also asked students about online interactions with history, including but not limited to interactive online history exhibits sponsored by museums. The responses again showed interest in these types of changes, which is information that could be vital to museums and historical societies. Overall, this study is greatly important to both museums and those with a vested interestvin history, as it demonstrates directions that can be taken in order to increase museum attendance and the interest in history of the general population.

Project Mentor: John Grabowski, History

Studying Micro-structural Changes During Deformation using Digital Image Correlation

Nicholas Tatnall, Materials Science and Engineering

Digital Image Correlation (DIC) is a computer algorithm that uses images acquired of a sample surface during mechanical testing to provide local deformation measurements at varying size scales. DIC has two distinct advantages over conventional measurement techniques (strain gauges or extensometers): 1) conventional techniques require contact between the measuring device and the sample, which could damage sensitive samples or distort measurements, and 2) conventional techniques only provide macroscopic (bulk) strain measurement and can not provide local measurement of displacement fields. DIC relies on optical measures of strain and is inherently a full-field technique, which allows for local deformation gradients. The DIC algorithm, packaged with a GUI, assigns a grey value to each pixel in a user-chosen subset. The pixels are then tracked throughout the series of images and the displacement field is created: this can be done in either two or three dimensions depending upon the camera setup. By varying certain computational parameters such as subset size and "step" (how many pixels are tracked) the resolution of and calculation time for the strain measured in each image can be changed. Work was done in an effort to fully establish this relationship and use it in further experiments.

Project Mentor: Jennifer Carter, Materials Science and Engineering

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Analysis of Bifurcations and Abrupt Transitions in Energy Balance Models (EBM) coupled to green-house-gas emissions (GHG).

Robert Taylor, Mathematics and Physics

Simple energy balance models with temperature dependent albedo (reflected fraction of incoming radiation) can exhibit hysteresis and rapid transitions between "warm" and "cold" equilibrium states. Another important factor that affects radiative balance and mean temperature are greenhouse gases (GHG) that control outgoing radiation. They have multiple sources and sinks, natural and anthropogenic (man-made), and temperature could also affect those processes. We will develop and explore a coupled EBM + GHG dynamic model with temperature feedbacks linked to albedo and GHG. Our goal is to study possible tipping points (abrupt transitions) and hysteresis cycles in such systems. We shall also explore different inputs and control parameters that could affect abrupt transitions, like anthropogenic GHG emissions or frozen methane deposits. The models will include globally average ("zero-dimensional") EBM, and zonally average 1D EBM, and focus on CO2 and methane GHG

Project Mentor: David Gurarie, Case Western Department of Mathematics

MesoScale Deformation Mechanisms in Nickel-based Superalloys as Studied by Micro-Laue Diffraction

Aaron Thompson, Material Science and Engineering

Deformation in polycrystalline materials is a multiscale process dependent on interactions of dislocations at the atomic-, micro-, and meso-length scales (i.e. solute atoms, other dislocations, particles, and grain boundaries). The development of computational models of deformation will rely on experimental results acquired at these various length scales to validate results. The interactions of dislocations at the mesoscale require the collection of experimental data with a large field of view and 3D representation. This presentation will focus on data analytic techniques for correlating mesoscale experimental data collected by electron microscopy: crystal orientation and 2D strain measurements, and miro-Laue Diffraction: 3D structure, and accumulated dislocation content. Steps for integrating these datasets will be presented for informing and implementing in a physics based crystal plasticity model for a nickel-based superalloy.

Project Mentor: Jennifer Carter, Material Science

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Human Bipedality and it's Effects

Adriana Thompson, Anthropology and Evolutionary Biology

Bipedalism is something we as humans practice, but do not frequently consider. We walk about on two limbs in a striding gait, while the rest of the mammalian kingdom scurries about on four. How did we become upright? When did this happen? What are the advantages? Disadvantages? This paper looks into these questions, beginning with when this trait developed. It examines the two dominant schools of thought: Lovejoy and Stony Brook. The Lovejoy school follows the thought that hominids were bipedal, just as humans, from the beginning. In opposition, the Stony Brook believes that the transition from arboreal locomotion to terrestrial locomotion was more gradual, with hominids first splitting time between the trees and the ground, before becoming completely bipedal. The paper then explores three predominant theories on how and why this occurred: Thermoregulation by Wheeler, Endurance Running by Lieberman and Bramble, and Provisioning by Lovejoy. The theory of thermoregulation suggests that we became bipedal as a adaptation to reduce heat gain and assist in heat dissipation on the open savannah. The Endurance Running theory suggests that certain human characteristics, such as our striding gait can be attributed to adaptations for long distance running. Finally, the Provisioning theory indicates that our upright bipedalism can be tied to monogamy, and male provisioning to ensure offspring survival. Lastly, this paper will examine the advantages and disadvantages of upright mobility, from back pain to free hands.

Project Mentor: Lawrence Greksa, Anthropology

Incidence and survival of sebaceous carcinoma in the United States

Raghav Tripathi, Biology and Medical Anthropology

Background: Information on risk factors, incidence, and survival of sebaceous carcinoma is limited. The objective of the current study was to describe the incidence of and survival from primary sebaceous carcinoma. Methods: We used data from the 18 registries of the Surveillance, Epidemiology, and End Results (SEER) Program from 2000 to 2011. The cause of death, relative frequencies, five/ten year survival rates, and incidence rates were calculated. Each parameter was analyzed by age, location of occurrence (ocular/extraocular), race, sex, and SEER Registry. Results: Overall incidence was 0.32 per 100,000 person years for males and .16 for females. The incidence for males increased by approximately 11% over the decade, while that of females stayed constant over the decade. Incidence among women was 2.1 times lower than men (95% CI of rate ratio: 1.8-2.4). Incidence among whites was almost three times the rate among non-whites (95% CI of rate ratio: 2.7-2.9). 10-year relative survival of sebaceous carcinoma was 86.98% (95% CI: 80.33%-91.50%). The ten-year case-specific survival (deaths attributable to sebaceous carcinoma) was 36.84% (95% CI: 32.41%-41.27%). Conclusions: Increased age, male sex, black race, and anatomic location of extraocular as compared with the ocular were associated with higher all-cause mortality. Although the overall incidence of sebaceous carcinoma is increasing (primarily due to increased incidence in men), the overall mortality has decreased. In addition, male sex, black race and the extraocular sites of incidence were associated with higher mortality than the ocular sites.

Project Mentor: Jeremy Bordeaux, Dermatology

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Investment in the Age of Global Warming

John Turner, Department of Economics and Department of Environmental Studies

Today, many institutions are questioning whether or not they should continue to invest in fossil fuels. Universities like Stanford, cities like Seattle and Ann Arbor, and numerous religious institutions have made the decision to divest their investment portfolios of some or all stocks in publicly traded coal, oil, and gas companies. Others have questioned these investment decisions. Two questions here present themselves. Is fossil fuel divestment the right thing to do? And is it profitable?

To answer the first question, at least for Case Western Reserve University, I'm taking the question to members of the campus community. With advice from the Office of Institutional Research, I've prepared a survey meant to reveal how valuable, in monetary terms, the idea of a "sustainable investment policy" is to students, faculty, and recent alumni.

The other important question is whether or not coal, oil and gas stocks will be profitable to keep in the future. A two-part study by the UK think tank Carbon Tracker called Unburnable Carbon predicts that governments will eventually be obliged to prevent the further use of fuels that produce greenhouse gasses, which could diminish the value of hydrocarbon producing companies over a short period of time. There is a way to examine how this would play out by looking at a small-scale example that is happening today. In 2008, the State of New York passed a moratorium that prevented gas companies from exploiting gas reserves in the Marcellus and Utica shale formations. This summer, I am preparing a case study on the implications of this moratorium on gas companies that operated in the state.

Project Mentor: Justin Gallagher, Economics

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HemeChip for Early Diagnosis of Sickle Cell Disease and Other Hemoglobin Disorders

Ryan Ung, Biomedical Engineering

Every day, more than 1000 children are born with Sickle Cell Disease (SCD) in Africa. About 50-80% of these children die before the age of five years due to lack of diagnosis and treatment. In third world countries such as Africa, diagnostic tests for sickle cell anemia are not readily available at the point of care (POC). To be tested for sickle cell anemia, a patient must have his/her blood cell sent to a facility that has the necessary equipment. This process may take weeks or months. The World Health Organization recognizes a crucial need for early detection of SCD. To help solve this growing issue, we have developed the HemeChip to quickly, accurately, and cheaply detect SCD. The HemeChip uses cellulose acetate electrophoresis to separate hemoglobin based on their mobility. Using less than 5 microliters of blood (smaller than finger stick volume), the HemeChip can identify the major hemoglobin types A0, A2, S, C, and F in subjects with various hemoglobin phenotypes such as Hb SS, Hb SC, and Hb SA. The HemeChip results were validated against standard clinical hemoglobin screening methods such as bench-top electrophoresis and high performance liquid chromatography (HPLC). Hemoglobin types A0, A2, S, C, and F were successfully identified both visually and quantitatively. We have shown that HemeChip can distinguish between different types of hemoglobin disorders, including, homozygous HbSS (SCD) and heterozygous HbSC (hemoglobin SC disease). Separations between hemoglobin bands were visible to the naked eye. Quantitative analysis using ImageJ showed that the HemeChip hemoglobin percentages were within ±10% of the HPLC and bench-top electrophoresis results. In conclusion, the HemeChip identification and quantification of hemoglobin phenotypes Hb SS, Hb SC, and Hb SA were found comparable to the standard clinical methods.

Project Mentor: Umut A. Gurkan, Biomedical Engineering, Mechanical & Aerospace Engineering

Influence of a Leader's Gender on a Group's Confidence in Completing a Cognitive Task

Harini Ushasri, International Studies; **Manuel Liana**, Statistics and Cognitive Science

Gender stereotypes are prevalent in our society, some of which suggest that individuals with more traits considered to be masculine, such as high confidence levels, will be better team leaders. However, qualities such as better communication skills are also predictive of better leadership, yet are considered more feminine traits, which, overall, tend to not be as highly valued as masculine traits in the workplace. With these competing stereotypes in mind, examining how gender biases may affect group performance and psychological states when completing a task may improve our understanding of how to work best with each other. We examined whether the gender of a team leader impacted members' perceptions of collective efficacy, or the level of confidence members held about their team's ability to complete a task. Higher collective efficacy should impact team performance, so we ultimately tested how gender of the leader might impact team performance via team member efficacy beliefs. Data was examined from a sample of 27 undergraduate student teams in the lab, who faced a highly interdependent task, to which they would have to respond to an unforeseen problem in their coordination. Pre- and post-task collective efficacy levels were contrasted between teams with a female vs. a male leader. The results showed no significant differences in pre- or post-task collective efficacy between teams with leaders of either gender. Based on these results, we propose that factors such as high task interdependence and workload intensity may have shifted participants' attention from implicit concerns stemming from gender stereotypes to grappling with the challenges inherent in performance adaptation. These findings suggest that important task-based conditions can influence the effects of gender biases and can further our understanding of the implications of gender bias and in what circumstances they may or may not pose a threat to successful group work.

Project Mentor: John Paul Stephens, Organizational Behavior

A Comparison between pilot hole drilled by a Low speed drill and a High speed drill for Dental Implant insertion.

Kaveh Varghai, Biomedical Engineering

Introduction: Our goal is to improve primary stability of dental implants. We use a custom made apparatus to measure torque as a function of axial displacement of dental implants during insertion.   We used this apparatus to drill pilot holes prior to implant insertion.   Because the device rotates slowly, the drill bit chips the material instead of cutting through it. This could produce a rough surface effecting the torque needed to insert the implant. Clinical procedures use a high speed drill to make pilot holes. This project tests if a high speed pilot drill results in different torque displacement curves than slow speed drill data.
Methods and Materials: Max insertion torque was used to judge primary implant stability. Four polyurethane bone models were tested: two single density blocks and two multi-layered blocks. Pilot holes were drilled using high and low speed drills. Implants were inserted into the holes and torque vs. displacement data collected. Torque vs. displacement curves were constructed. The shapes of these curves and their maxima were used to assess differences between the two drill speeds. 10 implants were placed for each condition.
Results and Conclusion: With alpha=.05, we found an insignificant difference between average max torques. The standard deviations for each condition were significantly smaller for the high speed drill. Moreover, subtle structure in the slow speed torque vs displacement curves was not present with the high speed drill.   These results prove that previous max torque data collected using the low speed drill is similar to what would have been collected had high speed drills been used. However using a high speed drill produces less variability in the data providing more power in statistical analyses. Also, analyses of the torque vs. displacement curves looking at more subtle features than max insertion torque are best done using a high speed drill to maintain clinical relevance of the results.

Project Mentor: Steven Eppell, Biomedical Engineering

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Halogen-free Flame Retardation of Polypropylene: Comparison of 9 Organically Modified Ammonium Polyphosphate additives at varying concentrations

Daniel Villamil, Polymer Science and Engineering

Modified ammonium polyphosphate (MAPP) compounds were both singularly and co-compounded into the polypropylene matrix. The effects of the 9 different MAPP formulations versus neat polypropylene's mechanical, thermal decomposition, limiting oxygen index (LOI). Each of the 9 MAPP mixtures was compounded at 27, 30, and 33 weight percent. The performance of the additives as flame retardants with intumescent properties was characterized via UL - 94 vertical burning tests, LOI, and thermogravic analysis. The self same compounds effects on the Tensile and Izod impact performances were compared versus neat polypropylene. The performance of the samples did not evolve a clear trend involving the MAPP compounds indicating the solid phase and combustion mechanisms depend heavily on the inter-ammonium polyphosphate funcitonal groups interactions.

Project Mentor: David Schiraldi, Macromolecular Science and Engineering

A computational model of the Aplysia feeding grasper from MRI data

Kevin Wang, Computer Science

Aplysia californica, the Californian sea hare, is an experimentally tractable organism used in the study of the mechanisms that govern behavior. The Aplysia feeding system has been used as a model of the motor control of rhythmic behaviors. Biomechanics are an integral part of behaviors, but the biomechanics of the feeding system have not been as thoroughly studied as has neural control. This study aims to characterize the biomechanics of the feeding grasper, specifically the mechanisms that enable the grasper to fit through the jaws while the grasper is open. Using MRI data, we hypothesized that the radular stalk, a semi-rigid structure inside the grasper, moves towards and away from the leading edge of the grasper to allow for the grasper to fit between the jaws during feeding. Segmentation and analysis of MRI images show an increase in distance between the stalk and leading edge during various phases of feeding behavior. A kinematic model of the feeding grasper was constructed in Blender, a 3D modeling program, to visualize and explore the feasibility of the hypothesis. The results of the model support the hypothesis and showed that stalk motion could allow the grasper to change shape to fit between the jaws.

Project Mentor: Dr. Hillel Chiel, Biology, Neurosciences, Biomedical Engineering

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INCREASING COLORECTAL CANCER SCREENING

Moriah Watts, BSN

The average risk individual has a 1 in 20 chance of developing colorectal cancer (CRC) in their lifetime, making it the third most common cancer amongst men and women, and the second leading cause of cancer-related deaths. However survival rates are directly related to the stage of CRC at diagnosis. Even so, national screening rates are at 59%, with low-income individuals 2.5 times less likely to be screened. (Davis et al., 2013) The Catholic Charities Diocese of Pittsburgh serves the six counties of the Pittsburgh Diocese in Pennsylvania, with the majority of patients living in Allegheny County, through the Catholic Charities Free Health Care Center (CCFHCC), where low-income eligible patients receive care at no cost to them. Adhering with HealthyPeople 2020's vision, our study was designed to increase CRC screening rates from 11.5% to at least 70% (Cancer, 2014), and to increase the number of individuals counseled about these preventive screenings. Using current colorectal cancer screening guidelines, a visiting nurse saw all eligible patients at some point during their scheduled appointment to ask about their colorectal cancer screening history, assess and counsel them about their individual risk, offer a fecal occult blood test (FOBT) take-home kit, show the patient how to complete the test, provide a simplified instruction sheet, explain test instructions, and answer questions. If a patient accepted the FOBT, it was considered one successful screening regardless of compliance. We successfully completed the interview process with a CRC screening rate of 96.6%; however, further recommendations and research are needed to retain these new rates.

Project Mentor: Marilyn Lotas, Nursing

Improving Nutrition Knowledge Among Irish Traveller Children

Rachael Wieber, Nursing; **Breanon Glover**, Nursing

Health outcomes within the Irish Traveller population in the Republic of Ireland are on average poorer than in the settled Irish population. Many experts agree this is due to social determinants including accommodation, education, discrimination and lifestyle. Many health problems affecting over a quarter of the Traveller population relate to cardiac related issues. One way to improve health outcomes within this group is to provide more health education programming.This project focused on teaching nutrition to children, 8-12 years of age, in an Irish Traveller after school program.

The program goal was to increase the post-test scores related to specific nutrition topics. An educational program was developed following consultation with Irish Traveller public health workers and their coordinator to identify specify nutrition topics along with the best approach to reach local Irish Traveller children. Using this advice an 8-week program was created that aimed to increase nutrition-based knowledge while meeting the participants' education level and learning style and creating a program that was active, visual, and fun. The topics focused on the food pyramid, healthy portion sizes, and physical activity. Pre and post surveys were administered. Results indicated that there was an increase in post-test scores from 3.86 to 7.58 related to the food pyramid worksheet and from 11 to 14.9 on the food identification grid. Feedback from the children was very positive.

On completion of the program, a Traveller-friendly program guide that the employees at the afterschool program could use to continue the program in future years was developed.

Project Mentor: Dr. Mary T. Quinn Griffin, PhD., RN, FAAN, ANEF, Nursing

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The Effects of TANF on Low-income Single Parents

Kathleen Wieser, Economics

In the 1990s, the welfare program Aid to Families with Dependent Children had earned a pretty negative reputation. The lack of incentive to leave the program and with the difficulty of managing the growing welfare rolls combined with the media's portrayal of 'welfare queens' and other abusers of the system had the implication that tax dollars were being given away to those who were simply too lazy or irresponsible to hold down a job. The 1996 replacement to AFDC, Temporary Assistance to Needy Families, implemented several reforms. First, it placed time limits on enrollees to incentivize a return to the labor force. Second, it increased sanctions for failure to meet standards of reporting income or participating in work or job-training programs. The third mechanism of the reform was the removal of Medicaid and food stamp programs from TANF and the expansion of eligibility for these programs which would ensure that young children of low-income families would be able to stay healthy and not subject to the strict guidelines of TANF. Through the workings of these three mechanisms I will attempt to analyze how the instruments of the reform have affected the lives of those single parents who are eligible to receive benefits. Through a review of current literature on the demonstrated changes in the lives of this population, I have found changes in the degree of self-sufficiency the adults on TANF achieve as the attitudes of recipients towards the program and the attitudes of non-recipients towards those who elect to enroll.

Project Mentor: Mark Votruba, Economics

How the Social Stigma of Schizophrenia Lead to Mental Health Campaigns: A Review

Heather Wojanowski, Biology

A somewhat recent phenomenon in the United States and globally is the outcropping of social campaigns aimed to combat stigma and eliminate discrimination for those living with mental illness. This provides an interesting new area of anthropological study: impacting social, cultural, biological/medical and enthnospychiatric fields. In order to fully understand the reasoning behind and efficacy of said programs, it is necessary first to investigate the social and cultural factors impacting mental health. Thus, I set out to complete a comprehensive literature review regarding the topic of stigma of schizophrenia. As this subject is broad and has implications in several aspects of anthropology, it was necessary to divide the literature into several areas. Historical context, cross-cultural ethnographies, representation of schizophrenia in the media, and current anti-stigma campaigns are discussed. The synthesis of these complex sociocultural influences on the perception of schizophrenia serves to provide insight on present efforts to dispel stigma, and the ways in which these efforts can be improved upon in the future.

Project Mentor: Lee Hoffer, Anthropology

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A Novel Platform for Bone Regeneration through Stem Cell Therapy

David Wolfson, Chemical Engineering

Musculoskeletal tissue injuries are a major cause of long-term pain and physical disability and afflict millions of people worldwide. Repair of bone defects can be achieved by transplanting human mesenchymal stem cells (hMSCs) with bone morphogenetic proteins (BMPs) into the site of the bone defect. While BMPs promote bone healing, the short half-life and instability of BMPs require the administration of physiologically high doses or multiple dosages of BMPs. This may cause adverse effects and high treatment cost. Thus, there is a significant clinical need to innovate delivery of BMPs for bone regeneration. For this, we have developed a system of spontaneously forming coacervate microparticles embedded in hydrogels. We have demonstrated that the resultant microparticles can be utilized as novel platforms for localized, sustained BMP-2 delivery, with the capacity for the simultaneous encapsulation of hMSCs for bone tissue engineering. To do this, we used microencapsulation by complex coacervation, which can be formed upon mixing two oppositely charged polyelectrolytes in aqueous solution. This method has been widely studied for food science and drug delivery applications. However, there are no known examples of cytocompatible complex coacervate systems as potential three-dimensional biomaterials for tissue engineering, due to the harsh physicochemical conditions necessary to typically form them (i.e., low and narrow pH range and high temperature). Yet with our system, formation of coacervate microparticles, derived from the simple mixing of alginate and gelatin, was seen over a wide pH range and at room temperature. Thus, our system enables simultaneous creation of drug-laden microparticles and encapsulation of stem cells in hydrogels under physiological conditions, which can then be utilized as a novel platform for in situ localized, sustained BMP delivery to encapsulated stem cells in bone defects for bone regeneration.

Project Mentor: Eben Alsberg, Biomedical Engineering

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Project Mentor: Eben Alsberg, Biomedical Engineering

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Real Chairs for Real Kids

Daisy Wu, Biomedical Engineering; **Shruthi Srinivas**, Biomedical Engineering; **Helen Zhang**, Biomedical Engineering

Using the iterative design process of biomedical engineering, our team focused on creating a low cost pediatric wheelchair device for the large population of children with lower leg deformities in rural locations. The wheelchair needs to have effective movement in the tough terrain of India, be modular in order to accommodate a child's growth as well as be mass producible at a low cost to the consumer. There are numerous aspects of the wheelchair to consider for the child's safety, including the distribution of weight, the wheelchair tipping angles and the user-friendliness. Rather than focusing on the chair itself, the team determined that the easiest way to include all of the above characteristics while addressing the concerns is to focus on vital framework of a wheelchair and make it adjustable for all different sorts of chairs. Thus, the team has designed a free-standing frame with three connected wheels that forms the basis of the wheelchair. In order to save cost, this is the only piece produced with the entire design - the user is responsible for inserting a chair of their choice into the frame, thus enabling alteration of the size of the wheelchair by alteration of the chair size. The wheelchair is theoretically extendable and adaptable, allowing for a variety of chairs to be inserted, accommodating the child as they grow physically larger. Overall, the device will help support independent motion in children with physical deformities in India, and, ideally, will allow these children to take advantage of educational opportunities that they would otherwise be limited from.

Project Mentor: Colin Drummond, Biomedical Engineering

Roach Coach: Isolating Sensory Neural Signals by Restraining Cockroach Movement and Robotically Implementing Freely Moving Conditions

Dora Wu, Mechanical Engineering and Music Performance; **Lyall Glait**, Systems Biology; **William Breckwoldt**, Mechanical Engineering

Animals rely heavily on their senses to survive in the wild. Prey animals, like cockroaches, need to be able to sense predators in their environments and implement survival strategies. The central complex is a sensory processing area in the insect brain that plays a role in directed movement. Previous experiments have recorded from the central complexes of freely moving cockroaches, but proprioceptive input from positional and kinesthetic sensors was indistinguishable from the external sensory information. To solve this problem, this experiment isolates cockroaches' sensory neural signals from their proprioceptive neural signals by restraining the cockroaches and moving them on a motorized frame called the Roach Coach.

The Roach Coach is a platform that translates and rotates restrained roaches within a 40cm by 40cm acrylic arena. Its movement paths can be generated by tracking freely moving cockroaches, by using an algorithm that mimics cockroach movement, or by manually inputting a path. With the Roach Coach, we can record neural activity in the central complex of a cockroach as it is being transported around the arena. Because the cockroach is unable to move, we are able to record neural activity related purely to sensation without proprioceptive feedback.

Project Mentor: Roger Quinn, Mechanical and Aerospace Engineering

Return to School Interventions and Strategies for Pediatric TBI

Joe Xiang, Psychology

Introduction:
Traumatic Brain Injury (TBI) is an injury that is typically the result of a sudden violent blow or jolt to the head, which can cause both temporary and long lasting dysfunction and damage in the brain cells. TBI injuries are especially prevalent in young children less than 5 years of age and can have lasting effects on a child's academic and intellectual abilities. This review will analyze results from published studies to identify the most effective strategies for TBI interventions.

Methods:
PsycINFO, PubMed, and ERIC databases were used to conduct a thorough and comprehensive search of published journal articles. Research studies that were highly relevant to traumatic brain injury, and included aspects of school reintegration, reentry, or intervention strategies were included in this review.

Results:
Three main forms of interventions were identified: school based intervention, instructor intervention, and counselor assisted intervention. School based interventions focus on providing information regarding TBI injuries to the school district in order to prepare a school environment for the child. Instructor based interventions aim to train teachers to provide proper reinforcement and help to improve academic and behavioral functioning in TBI children. Finally, counselor assisted interventions assist with setting up a proper home environment.

Discussion: The literature examined provide a detailed initial analysis regarding the types interventions for children affected by TBI. However, there remains a lack of knowledge about the effectiveness of these interventions. Future studies should focus on providing empirical results to determine the best interventions for pediatric TBI in order to facilitate a positive outcome when the child returns to school after injury.

Project Mentor: Lee Thompson, Psychology

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Fluid dynamics of flow induced by nodal cilia

Mengjie Xu, Applied Mathematics

Nodal cilia play an important role to left-right asymmetry in the early development of mammal embryos. We built a model to investigate fluid properties for flows induced by a processing cilium. Utilizing regularized Stokeslet method and image system of regularized Stokeslet, we solve the system numerically. We explore trajectories of the fluid tracers in the flow with one cilium or multiple cilia presenting in the system.

Project Mentor: Longhua Zhao, Department of Mathematics, Applied Mathematics and Statistics

Iron chelation with Desferoximine-B leads to bacterial flux and delayed wound healing

Jessica Yang, Biochemistry and Psychology

Chronic leg ulcers affect 2% of older adults. Venous reflux disease (VRD) contributes to up to 80% of chronic leg ulcers. VRD leads to red blood cell leakage from leg veins, resulting in accumulation of iron deposits in adjacent skin. Iron is a micronutrient that enhances microbial growth, which can pose a problem in healing. Desferoximine-B (DFX) is an iron chelator that aids in the removal of excess iron and may help leg ulcer healing. Here we utilized a previously described iron-overloaded (IO) murine system to simulate the skin iron deposition in chronic leg ulcers and determine the influence of iron chelation on bacterial colonization and healing in IO cutaneous wounds. A subset of mice received subcutaneous periwound injections of DFX 2 days before and after wounding for a total of 10 mg. Wounds were created by excision of full-thickness skin from the mouse dorsum. On wounding day, the wounds were inoculated with 1000 CFU Pseudomonas aeruginosa to better determine the influence of iron on a non-indigenous and siderophilic bacterial species that is commonly isolated from the chronic leg ulcers of VRD patients. Wound images and swab samples were collected at wounding (before P. aeruginosa inoculation) and throughout healing for wound measurement and microbiome analysis. DNA was isolated from the wound swab samples to identify bacterial communities by PCR amplification of the V3-V4 regions of the 16S rRNA bacterial genome and next-generation sequencing using the Illumina MiSeq platform. Wound measurements showed that DFX injections led to an increase in wound expansion and delayed healing, most markedly in IO mice. Microbiome analysis demonstrated a flux of bacterial communities related to DFX treatment. In conclusion, contrary to what was expected, DFX treatment impedes healing and contributes to increased microbial bioburden in cutaneous wounds, potentially by making iron more bioavailable to wound bacteria.

Project Mentor: Marie Tuttle, Dermatology

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Protein-protein Interactions between Nesprin and Myosin IIB Reveal the Mechanism of Nuclear Deformation in Cell Migration

Aishwarya Yenepalli, Biology, Chemistry

Nuclear translocation, increasingly thought to be a rate-limiting step in 3D cell invasion, may have crucial roles in cancer metastasis. Initial studies have suggested that the cytoskeletal proteins, specifically myosin II isoforms, are involved in cell migration. However, the mechanisms are not well understood. The Egelhoff lab has conducted 3D collagen assays that suggest that myosin IIB, as part of the actomyosin network, exerts tension on the nucleus, compressing it. This facilitates nuclear movement through tight spaces during 3D cell migration. Nesprin is a nuclear membrane protein that is part of the LINC protein complex that binds both the nuclear lamina and the actin cytoskeleton. Studies from this lab have also suggested that when the LINC complex was disrupted, the nuclear height increased significantly. These studies have led to the hypothesis that myosin IIB may indirectly interact with the nesprin-binding complex to exert force on the nucleus. In this project, I will use immunoprecipitation assays to determine any protein-protein interactions between nesprin and myosin IIB, and fluorescent immunomicroscopy approaches to help validate myosin IIB interacting proteins in live cells. This will allow us to determine the mechanism by which myosin IIB compresses the nucleus, and its role in breast cancer metastatic behavior.

Project Mentor: Dianne Kube, Biology

Non Verbal Communication Gestures in Autism Spectrum Disorder

Victoria Zagorski, Psychology

Autism Spectrum Disorder (ASD) has quickly become one of the most prevalent pervasive developmental disorders in the world. The Center for Disease Control (2014) reported that 1 in 68 children born in the United States are being diagnosed each year. Along with the dramatic rise in diagnoses the barrier of non verbal communication has grown. Some children with ASD have difficulty using gestures as a form of communication with others. These gestures fall into two different categories, deictic or expression with intent to request or declare something and representational, which is referring to an object, person, location, or event. The purposed of this project is to review the past literature on non verbal communication in the use of gestures. Previous research t on gestures in ASD has been very limited and focused more on behavior than the connection between people while having a conversation. Much more research needs to be done to further understand and measure the gestures used by people with ASD.

Project Mentor: Anastasia Dimitropoulos, Psychological Sciences

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Quality of Pretend Play in Relation to Frequency, Type, and Enjoyment of Video Game Play

Miriam Zegarac, Psychology and Cognitive Science

Children use pretend play to entertain themselves, socialize, regulate emotions, and practice real-world situations. Pretend play involves the use of fantasy, transformations, and imagination in the play process; stronger pretend players are more likely to have a stronger capacity for creativity, problem solving capabilities, and emotion-regulation skills. Children's play methods have expanded to include video games; the average American household has a video gaming system. Various researchers have noted the benefits of video gaming, but have not directly investigated the relationship between pretend play and technological play. Children in grades 2 through 4 from a local private school are being administered the Affect in Play Scale. The Affect in Play Scale task is recorded and coded to produce scores that measure quality of pretend play. The Video Game Questionnaire is used to determine video game preferences, frequency of use, and type of video games played. Games will be categorized into creative and non-creative types. Correlational analyses will be done for scores on the APS and the Video Game Preferences Questionnaire to determine if quality of pretend play is related to enjoyment of video games, frequency of video game play, and whether the child expresses interest in playing more video games. Mean Affect in Play Scale scores of children whose favorite game is creative will be compared to mean scores of children whose favorite game is non-creative in an analysis of variance. It is hypothesized that higher quality pretend play will indicate a preference for creative video games. Additionally, it is hypothesized that significant correlations will be present for scores on the Affect in Play Scale and Video Game Preference Questionnaire. This study has the potential to provide insight into children's gaming preferences as they relate to their pretend play abilities, creative capacity, problem solving skills, and emotional regulation.

Project Mentor: Dr. Sandra Russ, Psychology

Electroactive Polymer coating for Oil and Water Separation

Mo Zou, Chemical Engineering

A facile, one-step, and single-component fabrication of superhydrophobic and superoleophilic coating by electropolymerization of polythiophene on a stainless steel mesh is presented. The resulting coating has low surface energy and showed surface morphology bearing both micro- and nano-features without the need to add nanofillers, or pretreatment of the substrate to make it rough. It has been demonstrated that the coated mesh let oil to pass through but not water. Doping the mesh reverses the wetting property. The film was characterized using SEM, XPS, and FT-IR Spectroscopy.

Project Mentor: Professor Advincula, Macromolecular Science & Engineering

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