2015-2016
Undergraduate Research Award
Scholars and Abstracts

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Hollie Adejumo, Chemical, Biochemical and Environmental Engineering
"Occurrence of Fluoroquinolone Antibiotics in the Environment: Association with Resistant Bacteria and Resistance Genes"
Faculty Mentor: Lee Blaney
Expected Graduation Date: Spring 2016

Municipal wastewater contains a variety of contaminants, including fluoroquinolone antibiotics, which are powerful drugs that inhibit bacterial growth. If these antibiotics are not removed during wastewater treatment, then antibiotic-resistant bacteria are able to dominate. Resistance genes in these organisms are capable of spreading through plasmid-mediated transformation mechanisms, further intensifying the threat of resistance gene emergence. The purpose of this work is to study the occurrence of fluoroquinolone residues and select quinolone-resistant enterobacteriaceae in a wastewater–impacted river. I will test the hypothesis that the concentration of fluoroquinolone antibiotics found in wastewater correlates with the proportion of antibiotic resistance genes detected. Both upstream and downstream surface water samples will be collected and analyzed for fluoroquinolone concentrations. Water samples will be filtered, incubated on violet red bile glucose agar plates, and tested for fluoroquinolone-resistant bacteria through the combination disk test. The colonies on the agar plates will be enumerated, and the final E. coli concentration will be determined. To investigate the transfer of DNA from resistant bacteria to non-resistant bacteria, bacterial conjugation experiments will also be conducted. The wastewater sample results will be compared to a control E. coli standard cultured in the lab. These results will be evaluated by determining the gene transfer efficiency, which will be calculated to estimate the number of transconjugates per cell. These calculations will be used to understand and determine the magnitude of resistance gene spread in the environment.

Jackie Airhart, English
"Delighting Inventiveness: Tracing the Poetic Process of Seamus Heaney"
Faculty Mentor: Michael Fallon
Expected Graduation Date: Fall 2015

Seamus Heaney, a Nobel Prize-winning poet who passed away in 2013, delivered a series of lectures while he was a professor at Oxford. In them, he argued that while poetry is a necessary tool to correct societies' injustices, it also needs to exist for and of itself. Heaney advised that "poetry cannot afford to lose its fundamentally self-delighting inventiveness, its joy in being a process of language as well as a representation of things in the world." With his admonition to focus on the joy of language in mind, I am planning to explore Heaney's writing process by tracing the evolution of his work from the initial spark to the final published poems that have received so much acclaim by reviewing his draft manuscripts at the National Library of Ireland. Doing this will allow me to better understand the mind of one of the world's most beloved poets, as well as allow the chance to test the veracity of his lectures' declarations by comparing early iterations of poems against final works and testing whether the initial "self-delighting inventiveness" survived the editing process. During and after this research, I will have the added benefit of furthering his influence on my own creative work, where I will emulate elements of his prosody and style; with emphasis on his imagery, consonance, and use of narrative.

Theophilus Aluko, Mechanical Engineering
"Low Reynolds Number Aerodynamics and Mechanics of a Barn Swallow Bird"
Faculty Mentors: Meilin Yu and Jamie Gurganus
Expected Graduation: Fall 2016

Due to their tremendous agility and maneuverability in flight, barn swallow birds have the potential to provide new insights into how to improve the agility and control of commercial aircrafts, thereby making airplanes a safer travel option for all. Computational Fluid Dynamics (CFD) animations and practical experiments are important tools for determining and ultimately mimicking the natural flier's lift mechanism. In this study, I will make a 3D rendition by 3D scanning a thawed barn swallow bird specimen (at different wing positions) from the Smithsonian Museum of Natural History to create an animation of its flapping motion which would be fed into a basic CFD software. This visualization will serve as a way to speculate about what enhances its propulsive efficiency and lift, based on the bird's geometry and leading edge vortices (LEV), a feature due to the leading edge of the wing. Using our 3D rendition for geometry, and taking into account weight distribution factors over the bird's body, a mechanical assembly of the bird will be 3D-printed and skin-clothed to analyze and compare with the CFD animation. The assembly will be flight-tested and videotaped. The results will be evaluated by determining the relationship between the CFD animation and the flight-test model. We speculate that if the mechanical assembly does fly, it means the geometry and LEV mimicked in the mechanical model were enough to make it fly, and that any other factors like tail actuations and neural activities of a real bird, would further aid a safe and controlled flight.

Robin Arnold, Psychology

"Exploration of Health Disparities in Urban Settings: Community Stress and its Relation to Pain and Structural Brain Changes"
Faculty Mentor: Raimi Quiton
Expected Graduation Date: Spring 2016

The anterior cingulate cortex, prefrontal cortex and anterior insula are brain structures associated with pain perception and processing. Literature shows that structural changes, such as abnormalities in cortical thickness, in these areas of the pain network are associated with chronic pain conditions. Higher rates of chronic pain have been found in individuals with lower socioeconomic status. The application of environmental approaches has been widely accepted and successful in cardiovascular medicine, but is novel to pain medicine. Utilizing data from Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study, an epidemiological study following >3,000 participants over 20 years, this research will examine disparities in health involving pain in low-income communities in the Baltimore area. Structural MR Images will be analyzed in conjunction with correlation to a composite measure of neighborhood disorder and bodily pain scores.

Hye Min Baek, Chemistry and Biochemistry
"Creating Synthetic Cell Environment to Observe Selective Protein Interaction"
Faculty Mentor: Minjoung Kyoung
Expected Graduation Date: Spring 2016

Cancer is a major worldwide health concern. Its development is highly unpredictable and often unnoticed in its early stages. Therefore it is imperative that we understand how cancer develops in the first place as we seek prevent its onset and provide better treatments. We propose to develop an assay that will enable us to observe selective protein interactions in breast cancer development on the molecular level, which will ultimately help us identify new targets for more effective drugs. Synthetic vesicles will be created and incorporated with SNARE proteins (Sso1pHT, Snc2p and Sec9c) on their membranes to facilitate cell fusion. These cells will contain the proteins of interest, which will be tagged with fluorescent dye and whose interactions will then be studied under the fluorescent microscope.

Gabriella Balaa, Biochemistry and Molecular Biology
"Quantitative Analysis of Purine Nucleotide Pools"
Faculty Mentor: Songon An
Expected Graduation Date: Spring 2017

The purpose of this research is to examine a possible regulatory loop between AMP activated protein kinase (AMPK) and the multi-enzyme complex termed the "purinosome," which is composed of six cytoplasmic enzymes involved in human de novo purine biosynthesis. AMPK has been well documented as the "master energy regulator" of the cell, though its effects on purine biosynthesis have yet to be thoroughly investigated. This project seeks to determine if AMPK-mediated fluctuations of purine nucleotide pools are correlated with the metabolic activity of de novo purine biosynthesis. We have developed a high performance liquid chromatography method to quantify the purine nucleotide pools as cellular AMPK is activated with small molecules. Along with fluorescence live-cell microscopy, this methodology will allow us to determine the effect of AMPK activity on de novo purine biosynthesis and would give valuable evidence for the role that purine biosynthesis plays in cellular energetics. Because of the link between purine metabolism and chronic diseases, understanding the regulatory mechanisms of de novo purine biosynthesis could lead to therapeutic intervention.

Nicholas Bolden, Chemistry and Biochemistry
"*Using Alternative Methods to Elucidate the Monomer-Dimer Equilibrium of the HIV-1 5' Leader*"
Faculty Mentor: Michael F. Summers
Expected Graduation Date: Spring 2016

The currently accepted method for determining the monomer-dimer equilibrium of a sample is gel electrophoresis. This process involves using an electrical current to separate the monomer and dimer based on charge and size. Since RNA is negatively charged, the electrical current causes it to run towards the positive cathode; however the magnesium, which is essential for the dimerization process, is drawn towards the negative anode. This attraction to opposite poles causes the magnesium to be stripped from the dimer. When magnesium is stripped from the dimer while the gel is running, it causes some of the dimer to dissociate into a monomer, which leads to the measured equilibrium having more monomer than the true equilibrium. The goal of my project is to develop an improved technique for separating and visualizing the monomer-dimer equilibrium of the Human Immunodeficiency Virus (HIV-1) 5' Leader, in a manner that eliminates the need for an electrical current. The two main alternatives that are being investigated are high performance liquid chromatography (HPLC) and the use of centrifugal force. There are protocols available for separating monomer and dimer structures using an HPLC. I will be attempting to modify these procedures in an attempt to be able to separate the monomer and dimer HIV-1 5' Leader RNAs based on their different sizes. I will also be looking into modifying ultracentrifugation techniques through the use of different chemical medias for separation, such as polyhydric alcohols, polysaccharides, inorganic salts and iodinated gradient media to see which are effective. I will be comparing the results of the HPLC, ultracentrifugation, and gel electrophoresis data for each of the equilibria to look for consistency among the results. The final product of this project is a method to separate the monomer and dimer that will prevent the magnesium from getting stripped from the dimer.

Syrena Bracey, Chemistry and Biochemistry
"Investigation of Phosphofructokinase as a Scaffold Protein within the Glycolytic Pathway"
Faculty Mentor: Songon An
Expected Graduation Date: Spring 2017

We are currently studying a potential functional multi-enzyme complex that regulates glucose metabolism. It has been found that when a cell is stimulated, phosphofructokinase (PFK), a key regulatory enzyme that catalyzes a committed step in glycolysis, forms cytoplasmic clusters within the cell and co-clusters with other enzymes involved in glucose metabolism. According to our study of the spatiotemporal organization of glycolytic enzymes, we hypothesize that PFK is a scaffold to other enzymes within the glycolytic pathway. We will knock out the gene encoding PFK, using the Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)/Cas system and study how the glycolytic enzymes behave in the absence of PFK. Furthermore, the CRISPR-edited cell line will be employed for co-localization microscopy to reveal that co-clustering with the other glycolytic enzymes is rescued in the presence of exogenously expressed PFK. Because glucose metabolism is known to be up-regulated in cancer cells, gaining more insight into this enzyme's role in the pathway will allow us to understand how glucose metabolism is regulated and ultimately, what can be done to prevent its manipulation by cancer.

Devyn Catterton, Biochemistry and Molecular Biology
"Synthesis of CdSe and Au Nanoparticles Assemblies to Study the Optical Properties of New Hybrid Nanomaterials"
Faculty Mentor: Marie-Christine Daniel
Expected Graduation Date: Spring 2016

It is predicted that when the coupling of cadmium selenide quantum dots and gold nanorods occurs the properties of the resulting system will be qualitatively different from the properties of the isolated particles. These properties can further be controlled by exciting the system with a short laser pulse. This project is important because it will show that the nanoparticles assemblies can serve as a key enabling technology for future optical information processing at high speeds and low powers, including quantum-mechanical information processing at the single-photon level (i.e., quantum computers). This also has potential applications in providing a more efficient conversion of sunlight into electricity and in enabling highly efficient displays and ultra-small lasers. The goal of this project will be to couple cadmium selenide quantum dots to gold nanorods in order to study the optical properties of this new type of hybrid nanomaterial.

Mitchell Cherry (left) and Julian Loiacono (right), Computer Science and Electrical Engineering
"Transcranial Magnetic Stimulators for Mouse Brain Stimulation"
Faculty Mentor: Dr. Fow-Sen Choa
Expected Graduation Date: Spring

Transcranial magnetic stimulation (TMS) is currently the most widely accepted noninvasive and safe method for brain tissue stimulation. It also has been tested as a treatment tool for various neurological and psychiatric disorders including migraines, strokes, Parkinson's disease, dystonia, tinnitus, and depression. Current TMS tools are not well focused and have issues in reaching the depth necessary for deep brain stimulations. In this research, we will test the feasibility of a controllable pulse width TMS (cTMS) in array configuration by designing and building a small TMS system for mice. To test the system, the neuromuscular reactions of mice at Maryland Psychiatric Research Center will be scrutinized.

Kritika Chugh, Biological Sciences
"Xenobiotic Exposure Induced Morphological and Molecular Changes in the Mouse Olfactory Epithelium"
Faculty Mentor: Weihong Lin
Expected Graduation Date: Spring 2017

The main olfactory epithelium (MOE) in the nasal cavity plays an essential role in odor detection and transmission that aid in the survival of the organism. Inhaled xenobiotics, including irritants and harmful microorganisms, negatively impact the MOE sensitivity and integrity. The epithelium contains supporting cells, such as the basal and microvillous cells, whose functions remain mostly unknown. Based on the published results from our laboratory, we hypothesize that the microvilli cells may aid in xenobiotic detection. The main purpose of this project is to determining morphological changes in the MOE when mice are exposed to harmful irritants and determining the role of the microvillous cells by comparing wild type mice and Skn-1a-/- mice lacking microvillous cells. I am currently involved in characterizing putative xenobiotic receptor in the microvillous cells. My additional goal is to finish the quantitative molecular analysis of these receptors. Completing this project will aid our understanding of protective mechanisms that maintain the integrity of the MOE and protect vital organs such as the lung and brain.

Joelle Cusic, Chemistry and Biochemistry
“Study of Binding Affinity of Crotamine-Au Nanoparticles with DNA”
Faculty Mentors: Richard Karpel
Expected Graduation Date: –

Crotamine is a toxin that is present in the venom of Crotalus durissus terrificus, the South American rattlesnake found in Brazil. It has been shown to have a preference for targeting rapidly proliferating cells, such as malignant cancer cells, and displays numerous other functions, including DNA delivery and localization to the nucleus upon penetrating the cell. Thus, crotamine is an attractive candidate to be used as an instrument in a drug delivery or multifunctional system. Linking crotamine to a gold (Au) nanoparticle will enable crotamine to become part of a multifunctional system, which has been the long term goal of the studies on crotamine. Determining the binding affinity of crotamine-PEG-GNP to heparin and DNA is the first step in the long process of determining how effective the crotamine-PEG-GNP will be as a multifunctional system. Previous experiments have been performed to determine the binding activity of free crotamine to heparin and DNA using the cationic dye, azure A, which is a competitive assay. To obtain data on crotamine-PEG-GNP’s binding activity, the same assay will be performed with the exception being that crotamine-PEG-GNPs will be used rather than free crotamine. This will allow results to be compared. The crotamine-Au-nanoparticles that will be used in this experiment have already been produced, but the properties of crotamine, particularly that of binding affinity, when linked to PEG-GNP, have yet to be observed. Therefore, this project will aim to study the binding of crotamine-PEG-GNP to heparin, a highly sulfated carbohydrate chain that is similar to heparin sulfate proteoglycans present in cell membranes, and DNA. Studying the binding affinity of the crotamine-PEG-GNP for heparin and DNA will help to determine if the GNP will possess the properties of crotamine that have been observed using free crotamine and whether it will make a good multifunctional system that can be utilized in drug delivery.

Vineed Dayal, Mechanical Engineering
“Air Curtain Development: An Energy Harvesting Solution for Hinged Doors”
Faculty Mentor: Soobum Lee
Expected Graduation Date: Spring 2015

The goal of this project is to develop a fully mechanical air curtain system that will be powered solely by harvested energy from common hinged doors. The average person uses this type of door several times a day with an almost unconscious amount of applied force and effort. This leads to a high potential of energy to be harvested in doorways that see high traffic and frequent operation. Frequently opened door entry ways have always been regarded as a major element that causes significant energy loss and contaminated air conditions in buildings. Private companies, particularly those with warehouses, have introduced commercial electrical air curtains to block the open entrances from invading cold air. This project intends to introduce an original design of air curtain which operates fans only when the door opens and closes, by directly converting door motion to fan rotation without any electronic motor or power cable. The air stream created by this device will prevent the transfer of outside air and contaminants. Research will be conducted to determine the most efficient method of harvesting energy from door use, and the prototyping process will be conducted to meet the required performance of current air curtain models. The final prototype will be installed to one of the hinged doors on the UMBC campus and a conclusive field test will be performed to verify the usefulness of the device.

Elise Donkor, Computer Science and Electrical Engineering
"Heart Monitoring System for Personalized Arrhythmia Detection"
Faculty Mentor: Dr.Tinoosh Mohsenin
Expected Graduation Date: Spring 2016

The objective of this project is to build the foundations of an energy-efficient wearable biomedical device to monitor electrocardiogram (ECG) heart signals, specifically, algorithms to detect abnormalities in ECG signals from patients suffering from arrhythmia.Because ECG signals have universal characteristics and are easily obtainable, they serve as a highly efficient diagnostic tool for a variety of wearable monitoring systems including sleep monitoring, stress/anxiety monitoring and even help with some neural disorder monitoring such as seizure detection. The electrical impulses generated by a pumping heart will allow for monitoring abnormality detection. These algorithms can pave the way for biomedical devices that can detect when these serious changes occur, and alert a caregiver.

Emily Eaglin, Visual Arts
"Marylandia: The Web Series"
Faculty Mentor: Vin Grabill
Expected Graduation Dates: Spring 2017

What is culture in Maryland, and how does it relate to the arts and to prominent social causes? This is the question I sought to answer, and in this seeking "Marylandia" came about. There is an abundance of talent and social activism in the visual and performing arts scene in the UMBC/Greater Baltimore area as well as throughout the state of Maryland. The purpose of my research is to document some of these brilliant minds, while at the same time, creating a truly unique connective thread for highlighting the juncture of Maryland bred art and social activism. "Marylandia" is a web series that will be filmed and launched online in the form of short YouTube videos focusing on selected Maryland social activists and artists who are especially creative and game changing in their message.

Chidera Ekeocha, Biological Sciences
"Production, Isolation and Purification of Mammalian Target of Rapamycin (mTOR)"
Faculty Mentor: Minjoung Kyoung
Expected Graduation Date: Spring 2016

In order to identify targets for new cancer drug development, the understanding of the mTOR pathway is necessary. The mammalian target of rapamycin (Mtor) is a highly conserved pathway that is essential in the regulation of cell growth and survival. The purpose of this experiment is the production and isolation of mTOR complexes by affinity purification. These mTOR complexes would be produced by transforming them into bacteria and harvesting more of the complexes. After the production of these complexes within the bacteria, they are purified. Nano-sized vesicles in which multiple sets of enzymes would be enclosed at an increased concentration in its own compartment. These multiple enzymes are labeled with fluorescent molecules for enhanced identification. The protein-protein interactions in the mTOR complexes are then observed in the presence and absence of specific signaling molecules involved in (mTOR) pathway. By understanding the processes in the pathway, we would then be able to identify possible cancer drug targets. The success of this research will be the identification of interactions that potentially lead to cancerous growth of cells and the future development of cancer drugs.

Samantha Eng, Biochemistry and Molecular Biology
"Assessing Phylogenetic Relationships and Testing Speciation Mechanisms in Darter Fish in the United States"
Faculty Mentor: Tamra Mendelson
Expected Graduation Date: Spring 2016

This study will use molecular methods to determine the relationships and mechanisms of speciation of *Etheostoma stigmaeum, E. jessiae, E. meadiae, E. obama, E. gore, E. teddyroosevelt, E. jimmycarter, E. clinton*and *E. akatulo*. This group of species (subgenus Doration) seems to be an excellent example of speciation by sexual selection because species differ mostly in male breeding color, which is a sexual ornament. There is a suggested phylogenetic hypothesis of this subgenus based on morphology and breeding colors. However, molecular techniques have not been used. A phylogeny based on molecular (DNA) data is critical in modern biology. The methods used will be amplified fragment length polymorphism (AFLP), since it has been shown to support relationships among darters, and mitochondrial gene sequencing. This study will also use behavioral observational techniques during the mating season to test hypotheses about speciation mechanisms that involve the mating preferences of males and females of different species.

Kolton Fodel, Computer Science and Electrical Engineering
"Electromagnetic Modelling and Measurement of Brain Phantom, Shield, and Probes"
Faculty Mentor: Dr. Fow-Sen Choa
Expected Graduation Date: Spring 2016

Transcranial magnetic stimulation (TMS) is a non-invasive method of causing depolarization or hyperpolarization in the neurons of the brain. It uses a rapidly changing magnetic field to induce weak electric currents in specific or general parts of the brain with minimal discomfort, allowing the functioning and interconnections of the brain to be studied. TMS offers a potential non-invasive method of treating many brain related ailments including Parkinson's disease, schizophrenia, Alzheimer's, migraines, and depression. To develop new types of TMS for deeper and more focused stimulation, we need to run simulations, calculate electromagnetic fields and potentials, and design new coils. We also need to build brain phantoms and vector field measurement probes in order to characterize different TMS designs. These vector probes include highly directional transient magnetic field probes and more importantly, induced electrical field (current density) probes, which are not commercially available at this moment. We also need to design and build a magnetic shield to block unwanted residual transient fields from reaching brain areas we don't want to be affected.

Adam Freitag, Interdisciplinary Studies
"The Gamification of Studying: A Game-Based Approach to Improving Study Attention and Retention"
Faculty Mentors: Joan Kang Shin and James Thomas
Expected Graduation Date: Spring 2016

While many studies have been done on the role of games in the classroom, almost nothing has been written on how games can be used to improve attention to and retention of material outside the classroom. Today's high school and college students live in a culture steeped in "serious gaming," that is, they take games as seriously as school or jobs, to the point that their skill in gaming may even present future employment opportunities. I intend to add to the small-but-growing body of research in educational gaming by "gamifying" homework and studying, based on concepts in psychology and education. My aim is to completely reimagine the outmoded process of studying by introducing a multiplayer video game of my own design that students actually want to play and where they finish a gaming session feeling they have coincidentally learned the classroom material. I will be randomly selecting 12-15 students from two sections of the fall 2015 INDS 330 "Ways of Knowing" course to spend the semester supplementing their homework and studying with this new game. Comparing to the rest of the students in that course as a control, my goal is to determine whether there is a statistically significant difference in the final grades between those who have played the study-based game and those who have not. Post-study interviews will provide further light as to if and how the game made the task of homework and studying more palatable and created better chances of information retention.

Brenda Gutierrez, Chemistry and Biochemistry
"Gold Micro-cylinder, Electrochemical Aptamer-Based (E-AB) Sensors for Measurement of Astrocytic ATP Release"
Faculty Mentor: Ryan J. White
Expected Graduation Date: Spring 2016

Abnormal astrocytic ATP release has been proposed as a potential astrocyte dysfunction in neurodegenerative diseases. However, the roles of astrocytic ATP release are not fully understood due to the lack of analytical tools. Electrochemical aptamer-based (E-AB) sensors can be used to measure the concentration of ATP released by astrocytes, providing further insight into its function in the brain. E-AB sensors use aptamers, or oligonucleotides, that bind a specific target such as ATP. Target binding causes an aptamer conformation change resulting in an increase in current that is quantitatively related to ATP concentration. To date, we have optimized a micro-cylinder-based ATP E-AB sensor and conducted measurements of ATP in buffer solution. These sensors will now be used to make bulk measurements of astrocytic ATP release from astrocytes cultured in a 3D collagen hydrogel serving as an in vivo mimic. In order to make these measurements, we first have to determine the percent signal changes corresponding with different ATP concentrations at room temperature and 37°C (temperature cells are incubated at) by performing calibration titrations. Once we conduct real-time measurements of astrocytic ATP release, we can then expose astrocytes to environmental stimuli known to cause ATP release and measure the change in the amount of ATP released by these cells.

Amelia Hallworth, Biological Sciences
"Investigating the role of PRR5, PRR7, and PRR9 in regulating plant immunity"
Faculty Mentor: Hua Lu
Expected Graduation Date: Spring 2017

Successful defense against pathogens is critical for the survival of plants. The circadian clock was recently shown to play a role in the regulation of plant defense responses. Some of the central genes of the circadian clock in the model plant *Arabidopsis thaliana* have been demonstrated to be involved in salicylic acid (SA) mediated disease resistance. One of these genes is known to bind to the promoters of the clock genes PRR5, 7, 9. However, whether PRR5, 7, and 9 are involved in defense is currently unknown. Individual single mutants of the genes PRR5, 7, 9 have been introduced to the acd6-1 mutant, which exhibits constitutive defense, cell death, and a dwarf phenotype, making plant size a convenient indicator for the change in defense levels. The double mutants acd6-1prr5, acd6-1prr7, acd6-1prr9, and the corresponding triple and quadruple mutants are in the process of being made. Upon identification of homozygous mutants, I will assess the plant phenotypes by measuring their sizes, SA levels, cell death, and P. syringae resistance. Analysis of the recovery of the wild type phenotype, if any, will show whether the PRR5, 7, and 9 genes act in a synergistic manner in the SA pathway. Significant phenotypic recovery would be evidence for roles of these genes in defense control.

John Hannegan, Physics
"Creating a Fiber-Laser Based THz System Using Electro Optic Polymers"
Faculty Mentors: Dr. L. Michael Hayden
Expected Graduation Date: Spring 2016

The aim of this work is to create a functional 1550 nm fiber-laser based THz system implementing nonlinear electro-optic (EO) polymers for THz generation and detection. A fiber-based THz system provides the opportunity for a more compact and inexpensive means of performing THz spectroscopy than current commercial systems. This new apparatus would find applications in fields such as medical imaging and security, where portable THz imaging would be much easier to implement than current, larger setups. Such a system also has the potential to be much cheaper, using inexpensive EO polymers as opposed to costly nonlinear crystals. Additionally, these fiber lasers provide functionality at a wavelength range for which there are not currently many useful devices. To implement such a design, I will produce and electrically pole specific EO polymers with properties that provide a broad bandwidth of THz emission through strong phase matching conditions. I will also learn and implement the techniques of asynchronous optical sampling (ASOPS) and electronically controlled optical sampling (ECOPS) that will be required to achieve higher signal-to-noise ratios in THz spectroscopy using the relatively low power fiber lasers. I will also create a LabVIEW program for data acquisition and control of many aspects of the setup. I will then be able to perform THz spectroscopy, and in the process determine important factors such as the best THz emitter and detector pairings, and the signal-to-noise ratio of the system. The effectiveness of the spectrometer will be compared to other existing THz systems to help determine its relative effectiveness.

Robyn Jasper, Biological Sciences
"Development of a CRISPR/Cas9 Genome Editing System for Green Algae"
Faculty Mentor: Stephen Miller
Expected Graduation Date: Spring 2017

Genome editing is used to test a gene's function through targeted mutations. The Cas9/CRISPR system is a new genome editing system is simpler than previously developed systems and allows for very specific mutations. This high specificity is due to the fact that CRISPR-associated (Cas) endonucleases bind to DNA via associated guide RNAs that permit precise targeting through base pairing. Cas endonucleases can delete or add bases to the genome, which allows for not only knockouts to determine mutant phenotypes, but also for tagging genes with reporters. However, a Cas9/CRISPR system has not been adapted for use with green algae, such as multicellular *Volvox* and unicellular *Chlorella. Volvox* is an important model organism for investigating evolution of multicellularity, and *Chlorella* is an important production organism in biotechnology applications. In this project I will be adapting an existing Cas9 vector for use in *Volvox*by using species-specific regulatory sequences, I will first target a test gene and analyze transformants for the known mutant phenotype for that test gene. If this new Cas9 vector produces successful transformants for this test target, then I will have constructed a viable genome editing tool for *Volvox*that I or others can modify to target genes suspected of being important for multicellularity. My system could also be easily adapted by others for use in *Chlorella*, to improve it as a biofuels and neutraceuticals production organism.

Su Hyoung Kim, Visual Arts
"The Influence of the Gwangju Art Biennale on the Cultural Life of the City"
Faculty Mentor: Preminda Jacob
Expected Graduation Date: Fall 2016

The Gwangju Biennale, held every two years in the city of Gwangju, South Korea, is a major exhibition of contemporary art in Asia. The Gwangju Biennale was founded in September 1995 to commemorate those who died for the Gwangju Democratization Movement of 1980s and to transform this social value into cultural arts. The research will study how the Gwangju Biennale has influenced society and space in the city of Gwangju. My research methods will include travel to Korea to interview organizers of the Gwangju Biennale and to collect. Photo documentation from newspaper archives and from private photo collections of family and friends who live in Gwangju. I will also review literature on the subject in English and Korean. I hope this research will help me to communicate the importance of contemporary art to my peers. I am eager to discover how much the South Korean nation has changed culturally over the past twenty years; specifically how the city of Gwangju and contemporary art have been maintaining a mutually beneficial relationship.

Sekar Kulandaivel, Computer Science and Electrical Engineering
"Detection and Mitigation of Anomalous Behavior in Embedded Automotive Networks"
Faculty Mentor: Nilanjan Banerjee
Expected Graduation Date: Spring 2016

The safety and security of drivers becomes crucial to the future of the automotive industry as advanced electronics permeate an automobile's control systems. As with any system that contains electronic and wireless components, an embedded automotive network is vulnerable to malicious attacks from internal and external sources. For example, if an external agent gains control of a parallel parking assistance system while a vehicle is in motion, then the agent may be able to sharply turn the steering wheel at high speeds and cause a severe accident. In order to combat a malicious attack on an automotive network, an algorithm to classify normal driver behavior versus behavior resulting from an infiltration by an external agent will be developed by accessing the raw communication data between the various electronic control units (ECUs) within a vehicle. The mitigation of the effects of these anomalies will include intervening with the source ECU that produces a malicious message and ensuring that the remaining systems counteract the resulting effects. The production of a deployable attachment for the on-board diagnostics port of an automobile that detects and mitigates a variety of infiltrations from external agents will serve to protect drivers from dangerous attempts to disrupt or disable the electronic systems within their vehicles.

Margaret LaCourse, Chemistry and Biochemistry
"Development of an Enhanced Method for Ions in Seawater"
Faculty Mentor: William LaCourse
Expected Graduation Date: Spring 2017

Aquariums are an important part of modern society, providing a way to explore the wonders of the ocean, a source of entertainment, and a platform for aquatic research. The National Aquarium in Baltimore makes its own seawater with a formulation of salts designed to match the composition natural seawater and provide aquatic life with the proper nutrients needed to grow and thrive. Assaying artificial seawater is essential for the proper maintenance of aquariums, and it is critical that ion concentrations be known with precision and accuracy. The goal of this project is to develop, optimize, and validate a robust method to determine halide ion (F-, Cl-, Br-, I-) concentrations in aquarium water. Previous efforts have resulted in an unvalidated method for determination of chloride and bromide in seawater, but the determination of fluoride and iodide is more challenging as their concentrations in seawater are relatively low, making it more difficult to detect them, and their chromatographic retention characteristics are at the extreme ends of the spectrum. I will develop and validate a single method to detect halide ions in aquarium water. The separation of the halide ions present in seawater will be performed using ion chromatography, which is a proven analytical technique. The separation will be optimized to resolve the halide series of ions in the shortest amount of time. The detection of the anions fluoride, chloride, and bromide is best achieved using conductivity detection, while the detection of iodide is best achieved using UV-Vis detection. This work will place the two detectors in series after separation by ion chromatography, so that all ions are detected in a single run. This approach should dramatically reduce the time of analysis.

Patrick Langan, Mechanical Engineering
"Pneumatically Controlled Stewart Platform"
Faculty Mentor: Lynn Sparling
Expected Graduation Date: Fall 2015

Stewart platforms (hexapods) are six degree of freedom motion platforms. The motion platform for which this research is being conducted is pneumatically driven, controlled by a Beaglebone Black microcomputer, and is currently capable of positioning a 200-pound load. Further development is required in order to obtain accurate high-speed positioning. Pneumatics are rarely used for accurate position control in systems with high forces in part due to the compressibility of air, which results in a great deal of added complexity to the control program. For accurate linear positioning, hydraulics and motor driven screws are most commonly used. Unlike pneumatics, these methods of control can set exact positions simply based on flow rates or turns of a motor. To position a pneumatic cylinder in a reasonably accurate manner there are additional complexities which must be accounted for. These complexities include air compression caused by external forces and the acceleration of the load, as well as the behavior of friction between the piston seal and lubricated cylinder wall. In addition, stiffness of positioning throughout motion must be maintained by maximizing pressure in both cylinder chambers. Pneumatics are being used for the control of this Stewart platform despite the increased complexity because, for the speeds required (~0.5m/s), hydraulics and mechanical actuators are prohibitively expensive. In addition to finding a model for the pneumatic cylinder's behavior, a closed loop positioning system will be required. The closed loop control will use a Kalman filter with the cylinder position model along with platform position measurements from an assortment of sensors in order to obtain an ideal set of pneumatic valve settings for a desired platform motion.

Justine Lottermoser, Biochemistry and Molecular Biology
"The First Electrochemical, Aptamer-Based Sensor on a Carbon Surface"
Faculty Mentor: Ryan J. White
Expected Graduation Date: Spring 2016

The most common hereditary mental developmental disorder, Fragile X Syndrome (FXS), is one of the few known genetic causes of autism. A recent study suggests FXS neurons can be rescued by interactions with healthy astrocytes, integral cells in the central nervous system, thus opening a potential new therapeutic strategy. Unfortunately, little is known about astrocyte-neuron interactions as there are no proper tools available to gain further insight. Adenosine triphosphate (ATP) is a molecular messenger utilized by astrocytes and is thus presumably an integral component in astrocyte-neuron interactions. Consequently, gaining information about the mechanism and spatial location of ATP release will advance our understanding of the role of astrocytes in FXS and autism. Our project is aimed at developing a tool capable of single-cell monitoring by fabricating an electrochemical, aptamer-based biosensor on carbon fibers. Aptamers are short DNA or RNA sequences selective for target analytes and translate binding into an electric signal. Carbon fiber represents a material suitable for single cell and in vivo analyses. Additionally, it has favorable electrochemical characteristics enabling high signal-to-noise measurements not achievable with current sensors. As such, we are developing a strategy for covalently linking aptamers to carbon electrode surfaces.

James Loy, Physics
"Charge Transfer from Single Semiconductor Nanocrystals to Single Molecules"
Faculty Mentor: Matthew Pelton
Expected Graduation Date: Spring 2016

Semiconductor nanoparticles are tiny crystals whose sizes are comparable to the quantum-mechanical wavelengths of electrons inside the material. Incident light can excite electrons within these particles to higher energies, and these high-energy electrons can then be transferred out from the particles in order to produce an electrical current or drive a chemical reaction. Understanding the fundamental process of charge transfer on nanoparticle scales will benefit research into converting sunlight into practical forms of energy. This project will study a model system of this charge transfer process to understand its dynamics. Organic molecules will be adsorbed onto the surface of the nanoparticles so that electrons can transfer from the nanoparticles to the molecules. The coupled nanoparticle-molecule systems will be analyzed to determine if the quantity of surface molecules yields a predictable effect on the rate of charge transfer. As electrons are transferred into the organic molecules, fewer electrons remain to decay to a lower energy state in the crystal and emit their energy as photons. The photon emission rate can then be related to the charge transfer rate. While this has been performed for collections of many nanoparticles, this project will rely on a microscopy unit specially built to handle individual nanoparticle optical analysis. This will remove the variations among nanoparticle-molecule assemblies that are inevitable in ensemble measurements, making it possible to determine quantitatively how the characteristics of the particles are related to the charge-transfer dynamics.

Sheung Lu, Computer Science and Electrical Engineering
"*Gesture of Recognition for Patients of Limited Mobility*"
Faculty Mentor: Dr. Nilanjan Banerjee
Expected Graduation Date: Spring 2016

Quadriplegia is paralysis in humans that results in partial or total loss of use of limbs and torso. This is caused by either illness or injury that damages the brain or the spinal cord at a high position (C1 – C7 vertebrae). Many quadriplegics cannot move their lower body and some have lost all functions in their arms. This project will focus mainly on individuals who have C5 through C7 injuries, where patients are able to move their arms but have paralysis in their hands. Most patients cannot fully extend their arms and have minimal movement in their wrists. Many cannot use and control objects around them, from simple light switches to using a keyboard, patients need assistance to perform simple human tasks. My aim is to provide an easy-to-use interface that will make these tasks simple to do. Capacitive sensors already exist today on many of our smartphones and touchscreen displays. I will replicate this in a wearable device using textile materials. Conductive thread will be embroidered into capacitive patches that will sense the presence and movement of an arm. A microcontroller will then detect the movement and translate it into gestures that a computer can recognize to perform a task. A patient would use move his arm in a triangle motion to type the letter ‘A’ for example or in a circular fashion to turn up the TV volume. These patients with limited mobility will once again be able to control their environment.

Jonathan Luckin, Physics
"Understanding the Mysterious Energy Content of the Lobes of Radio Galaxies through Numerical Simulations"
Faculty Mentor: Markos Georganopoulos
Expected Graduation Date: Spring 2017

The energy content of the radio lobes of powerful radio galaxies is an important unknown in the study of the effects of the radio lobes on galaxy and galaxy cluster evolution. Astronomers usually assume that the magnetic field and relativistic electrons in the lobes are in energy equipartition, a reasonable assumption because that configuration is most economical and minimizes energy in the radio lobe for a given level of observed radio emission. However, there is no physical argument or observational test in order to support or refute this assumption. In order to understand the energy distribution, we will first calculate the synchrotron spectrum of a model source with a given lobe energy content and a ratio of the electron to magnetic field density. Then, assuming a range of physically plausible distributions of the lobe energy content and electron to magnetic field density ratios we will use Monte-Carlo techniques to produce simulated radio galaxies. Using the calculation and the simulated galaxies, we will produce synthetic samples of radio galaxies that can be detected from a radio survey of a given sensitivity in order to evaluate how close the detected radio galaxies will be to energy equipartition.

Gaurav Luthria, Biochemistry and Molecular Biology
"Developing Algorithms for Structure Elucidation of Biomolecules"
Faculty Mentor: Dr. Michael Summers
Expected Graduation Date: Spring 2016

Ribonucleic acids (RNA) play a vital role in virtually all cellular processes and understanding the structure of RNA is important in investigating both gene expression and cellular functions. We are investigating approaches for RNA structure determination using modern energy optimizers such as Covariance Matrix – Adaptation Evolution Strategy (CM-AES) in conjunction with gradient-based minimization and molecular dynamics simulations. The goal is to develop an algorithm to efficiently and accurately compute stable RNA configurations. This approach utilizes a coarse-grain model, previously determined properties of RNA structures including pseudo rotation phase angles and planar base structure, and torsion angle probabilities from other known and previously elucidated RNA structures. We use multiple energy minimization methods to compute stable configurations of RNA. In the present study, we have used NMR data to determine torsion angle and atom distance constraints used by these optimizers. Derived structures and minimized energies for particular RNA molecules are compared to the previously determined structures by another remodeling software. The superimposition of our derived RNA structures to the known structure showed nearly identical resemblance in configuration. We are currently trying to elucidate structures of other biomolecules particularly protein and DNA.

Caitlyn Maczka, Biological Science
"Characterization of an Embryonic Skin Enhancer Element from the C. elegans pax-3 *Gene"*
Faculty Mentor: David Eisenmann
Expected Graduation Date: Spring 2016

A major topic in developmental biology is the question of how genes get turned on and off. Normal development requires correct cell fate adoption, which is controlled via differential gene expression. In the invertebrate model system *C. elegans*, it has been shown that gene *pax-3* is expressed in skin cells of the developing embryo. We hypothesize that*pax-3* is involved with the proper choice of cell fate by these skin cells during early worm development. The goal of this research is to identify the smallest possible DNA fragment that is both necessary and sufficient for expression of *pax-3*. PCR cloning and Gibson reactions will be used to make several *pax-3* reporter constructs in a way that they can be stably integrated into the nematode's genome. Pieces of the *pax-3* promoter region will be placed upstream of the GFP coding sequence. The DNA will be injected into *C. elegans* to make a transgenic strain, and then progeny will be analyzed for expression of the GFP reporter gene. Observation of GFP expression indicates that the region of DNA used contains binding sites for transcription factors involved in *pax-3* expression. After the smallest necessary and sufficient DNA fragment is identified, further studies will then find the specific transcription factors that bind to this DNA sequence (which regulates the *pax-3* gene). This knowledge will help to extend our understanding of how nematode skin cells adopt their specific cell fates during normal development.

Ahsan Mahmood, Physics
"Computational Analysis of Optical Properties of Quantum Dots Coupled With Nano-sized Metal Particles"
Faculty Mentor: Matthew Pelton
Expected Graduation Date: Fall 2016

A thorough understanding of the optical properties of coupled systems of metal nanocrystals and quantum dots is essential in developing applications based on these structures. For instance, assemblies of metal nanocrystals and quantum dots can be designed such that the coupled system normally transmits light, but no longer transmits when excited by a short laser pulse. In effect, the structure acts as an all-optical switch with low energy input, potentially enabling them to be used to process information with lower power requirements than current microelectronics. This optical behavior cannot be explained by the mere concatenation of those of the individual parts and, therefore, requires rigorous electrodynamic simulations, which are the subject of the project. Initially, I will reproduce published results, investigating different software packages, and fine-tuning the parameters involved in the calculations (space-time grid resolution for instance) in order to establish the reliability of the results. Once suitable parameters are found and a suitable code is established, I will extend the calculations to cover assemblies of nanocrystals with different compositions, shapes, arrangements, etc.

Brian McMullen, English
"The Cultural Connection of Antiquity and Modernity: A Photographic Study"
Faculty Mentor: Timothy Phin
Expected Graduation Date: Spring 2016

This project will assemble a collection of photographs that explores the relevance, commodification, co-optation, and preservation of ancient sites and structures in Italy and Greece. I seek to capture the lives of ancient places in their modern settings, and to assess how contemporary culture has or has not integrated antiquity. I want to trace not only the obvious connections between modern societies and their ancient forebears, but also to visually examine how modern societies consume and curate their own pasts. What does the past do for modern Greeks living in Athens? How do modern and ancient cities occupy the same landscape? How do they share a common space? How does the presentation and preservation of antiquity differ between a site like Pompeii, and a continuously inhabited one like Rome? Why is the Colosseum not referred to as the Flavian Amphitheatre? Using photography, both personal and archival, in addition to ancient and modern texts concerning these sites, I aim to assess the cultural evolution of these locations. The final product will be a collection of photographs each paired with a brief essay exploring these issues and assessing the cultural values associated with these sites.

Mariana de Matos Medeiros, Psychology

"Marital Adjustment among Parents of Children with Food Allergies"
Faculty Mentor: Dr. Lynnda Dahlquist, PhD
Expected Graduation Date: Spring 2016

The marital relationship is often considered to be the cornerstone structural component of the nuclear family. This study aims to determine whether a food allergy diagnosis in children affects marital relationships by comparing the marital adjustment of parents of healthy children versus parents of children with food allergy. Specifically, this study will examine a pre-collected sample of 60 preschoolers, ages three to five, who have a food allergy diagnosis and a sample of 60 healthy children. Marital adjustment will be measured through examining scored on the Dyadic Adjustment Scale, which use marital cohesion, consensus, satisfaction, and affectionate expression as instruments to determine degree of marital adjustment. Shedding light on marital adjustment among parents of children with food allergy can ultimately help pediatricians identify whether this new milestone in the parents' lives is one that causes major strain in the couple's relationship, thereby advising couples to be vigilant and seek help as a preventative measure. Moreover, with a cohesive marital relationship parents are better able to provide the support the child needs in order to cope.

Joshua Mele, Chemical, Biochemical, and Environmental Engineering

"Quantification of Carbon Emissions in the Baltimore Area"
Faculty Mentor: Christopher Hennigan
Expected Graduation Date: Spring 2016

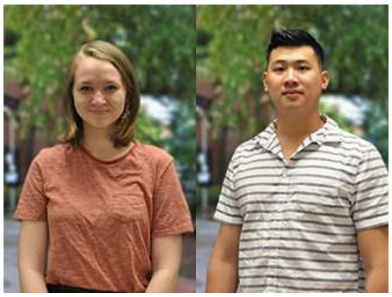
The focus of this research is to quantify the contribution of diesel and gasoline emissions to aerosol levels in the greater Baltimore metropolitan area. Aerosols are fine particles present in the atmosphere; this research will focus on elemental and organic carbon aerosols. These aerosols can have negative effects on both human health and the environment. Heart and lung diseases have been linked to aerosol exposures, along with decreased visibility and the modification of the Earth's climate due to the reflection and absorption of solar radiation by these particles. Aerosols also provide sites for chemical reactions to occur that can deplete stratospheric ozone. Carbon aerosols will be measured using a Sunset Laboratory Inc. Semi-Continuous OC-EC Field Analyzer. This instrument analyzes atmospheric samples to determine highly time-resolved organic and elemental carbon aerosol levels every 45 minutes. This data will be used in conjunction with carbon monoxide concentrations and traffic flow in Baltimore to determine the fraction of organic and elemental carbon contributed by diesel and gasoline emissions. By quantifying these aerosols and characterizing their sources, new policies can be developed to reduce their atmospheric levels and their associated effects, creating a cleaner and safer environment.

Nneka Opara, Psychology
"Ethnic Differences in Perceived Parental Psychological Control and Depressive Symptoms during Emerging Adulthood"
Mentor: Charissa Cheah
Expected Graduation Date: Spring 2016

Individuals between 18 and 25 years of age encounter new challenges during this period of emerging adulthood. The role of the parent evolves during this developmental period, along with controlling practices that parents may use. Parental psychological control includes practices that induce child compliance through psychological and emotional manipulation, which undermines children's autonomy development. Such practices are associated with negative psychosocial outcomes among emerging adults in Europe, but have not been examined among U.S. ethnic groups. This research aims to: (1) compare African American, Asian American and European American emerging adults on their perceptions of their parents' level of engagement in two forms of psychological control, dependency-oriented (forced dependence upon the parent), and achievement-oriented (guilt-induced motivation for achievement); (2) examine the relations between perceived parental psychological control and emerging adults' depressive symptoms; and (3) compare these associations between the three ethnic groups.

Jane Pan, Mathematics and Statistics
"Mathematical Modeling of Cancer using ODEs and Stochastic Processes"
Mentor: Dr. Hye-won Kang
Expected Graduation Date: Spring 2016

Performing tangible experiments concerning cancer can easily become expensive in terms of necessary equipment and the number of trials that accumulate in attempts of gathering more data. The purpose of this work is to determine the significance of stochastic noises in simple cancer models by varying the network topology and the parameters of interest. Using biological literature, we wish to create a model that we can simulate and compare with experimental results. The utilization of ordinary differential equations (ODEs) becomes necessary to describe the chemical reaction networks. Performing simulations based on these models on numerical computing environments such as MATLAB tests our approaches and methods in an efficient way while reducing error, allowing us to take immediate action for adjusting our existing model. We hope that implementing a wide range of trials will allow us to identify existing correlations between noise variations and its effects on signaling pathways, for doing so could provide scientists with a probable plan to undertake with their lab experiments, saving valuable resources and time.



Erin Patterson (left) and Brendon Thach (right), Visual Arts
"Bmore Than Dance: A Study in Organization Management"
Faculty Mentor: Alan Kreizenbeck
Expected Graduation Date: Spring 2016

Errigh LaBoo has contributed to the underground dance movement "Shake it Off" by managing troupes and individual dancers to compete against each other in the competition he created, "The King of Baltimore." The dance form is extremely entertaining, drawing on many elements of hip-hop, vogue, krump, and tap (to name a few) while adding the element of bracket competitions. It is also expressive, and serves as an emotional outlet for many dancers. This dance form has influenced the community that surrounds it, inspiring thousands of other dancers, who have created their own forms and styles of dance. We have heard many times how beneficial this dance competition is for the city of Baltimore. Through surveys and personal interviews, we have been told that the dance "keeps [them] out of trouble and off the streets." We have met many talented individuals who have a passion for artistic expression with no outlet to really explore it fully. We seek to create a larger organization out of LaBoo's competition series, which uses dance and art as a means to expand awareness and positivity to the community, for we believe this dance is highly beneficial in a community where the arts are not emphasized as an alternative outlet to destructive behavior. One of the main focuses of the program is to prove to the dancers that their talent is worth something and not to go give up. We have developed a team comprised of students and mentors to help with website development, public relations, communication, and marketing. These students are interested and involved in many different areas, including photography, anthropology, theater, graphic design, and computer science. Our mentors are experienced businesspeople who help us to efficiently manage and keep our team on track. Our team is responsible for promotion of the events, audience expansion, website upkeep, outreach to the community, finding sponsorships from other businesses, donations to charity through fundraising performances, and recruitment of students to join the dancers in their company. The organization will be giving back to the community that nourished it, including outreach to inner city public schools, lessons, seminars, workshops, and charitable donations.

Hayley Richardson, Mathematics and Statistics
"Using Nuclear Introns to Assess Gene Flow Between Old and New World Common Ravens"
Faculty Mentor: Kevin Omland
Expected Graduation Date: Spring 2017

The Common Raven (Corvus corax) is a bird species whose range spans across North America, Europe and Asia. Recent genetic analyses of Common Ravens indicate that this species has a very complex evolutionary history. Within the species, there exist two mitochondrial DNA lineages: the California clade (present only in the western United

States) and the Holarctic clade (which is found throughout the entire range). To better understand the evolutionary processes acting on this species, we must determine the amount of genetic intermixing between populations. Old World (Asia and Europe) and northern New World (Canada and northern United States) ravens are almost entirely Holarctic. Previous studies of gene flow between Old and New World ravens were limited to only mitochondrial DNA sequences and suggested limited gene flow between hemispheres. I will sequence about 20 New World individuals (ranging from Alaska to Maine) and 20 Old World individuals (ranging from Ireland to Russia) for seven nuclear introns. I will then use the program Isolation with Migration to estimate divergence time and amount of gene flow between the two populations. This research will shed light on the history of the Holarctic clade, which will be useful in future studies of raven evolution. Since ravens illustrate a dramatic case of speciation reversal, learning more about raven evolution will help us elucidate this process. Furthermore, interbreeding with formerly distinct lineages occurred in both raven and human history, so understanding speciation reversal in ravens could help uncover the details of human evolution.

Nicholas Rogers, Chemical, Biochemical and Electrical Engineering
"Characterization of Leaf Leaching into Stormwater Using EEM and PARAFAC Analysis"
Faculty Mentor: Lee Blaney
Expected Graduation Date: Spring 2016

Analysis of dissolved organic matter (DOM) is significant in studying the ecosystem, especially in regard to the cycling of organic compounds and polyvalent cations. DOM can serve as a fingerprint for water sources, affect biogeochemical processes, and identify and model water quality across certain regions. However, to more accurately model these trends, the sources of DOM must be identified, as well as the rates at which organics leach from those sources. As a result, this project seeks to use an analytical method in the form of fluorescence excitation-emission matrices (EEMs) to characterize DOM and to model the leaching rate of organics from leaf litter into water. Specifically, the leaching of organic matter will be characterized from nine species of leaf litter samples collected from the Baltimore city region. The data obtained from these experiments will be analyzed using mathematical tools such as regional integration and parallel factor analysis (PARAFAC). Overall, this study will provide insight into the composition of urban stormwater runoff as a source of carbon into the Chesapeake Bay.

Brent Runge, Biochemistry and Molecular Biology
"Benzoxazole-Based Metal Chelators as Novel Inhibitors of Hepatitis C"
Faculty Mentor: Dr. Paul Smith
Expected Graduation Date: Spring 2016

Hepatitis C virus (HCV) currently infects approximately 150 Million people worldwide and causes 500,000 deaths per year. As such, it is clear the current standard of care needs to be improved. Sovaldi represents progress in treatment of HCV, but has only been approved for combination therapy due to viral resistance. Combination therapy is the traditional method of preventing viral resistance, but requires expensive treatment, longer patient care, and complications due to multiple drug interactions. Our lab has identified three viral proteins (NS2, NS3, and NS5A) required for HCV replication that contain or share a structural zinc ion to maintain their function. Our lead compound has a high affinity for Zn^{2+}, thus it is hypothesized inhibition results from the chelation of these key structural zinc ions. The specific goal of my research is to improve the viral potency of our lead compound by synthesizing a series of analogs with a diamine of varying length. With the additional diamine as a Lewis base group we expect to see an increased affinity for zinc and, thus, increased HCV inhibitory activity.

Amirreza Saharkhiz, Mechanical Engineering
"Evaluating Accuracy of the Algorithm Used in Thermometers to Predict the Core Body Temperature Based on the First Few Seconds of Temperature Measurements"
Faculty Mentor: Liang Zhu
Expected Graduation Date: Spring 2016

Technology has been advanced to produce widely available non- or minimally-invasive home use digital thermometers that predict body core temperature. It is stated that those thermometers use an algorithm that incorporates temperature compensations or a predictive formula to project or estimate the thermal equilibrium temperature of the body based on temperatures measured only during the initial several seconds. The main objective of this study is to verify whether a simple exponential function can be used to predict the thermal equilibrium temperature at two measuring sites. Information collected can be used to evaluate how the temperature environment changes after placing a temperature sensor at a measurement site, and whether the temperature data measured in the first few seconds are sufficient to predict the equilibrium body temperature. I recruited 20 healthy human volunteers (10 males and 10 females, 20-30 years old) to record the temperature rising curve. Based on the data gathered, I will propose to use a function consisting of a summation of two exponential functions with different time constants. If the contribution of the second exponential function is not negligible, the accuracy of using a single exponential function to predict its equilibrium temperature will be questionable. I also will use statistical analyses (student t test) to determine whether a difference of mean values between two groups (male vs. female, oral vs. axillary, and left vs. right side) are statistically different, defined as the p-value less than 0.05.

Lena Shalaby, Mechanical Engineering
"Portable Electromagnetic Generator for Charging Mobile Electronics"
Faculty Mentor: Soobum Lee
Expected Graduation Date: Spring 2017

This research will study the ways of powering a mobile electronics (e.g., cellular phone) by harvesting the energy created from a rolling suitcase wheel. The rotational kinetic energy, created by the wheels, can be converted to electrical energy and generate power. Electromagnetism will be considered as a possible energy conversion principle in this research. This principle is observed when there is a fluctuation of magnetic flux density that can be generated from changing the distance between a magnet and coil. The change in magnetic flux density creates an electromagnetic voltage, thus generating an electric current. The magnetic flux change can be easily implemented in a rolling wheel mechanism. This research will investigate various conceptual designs to figure out the most efficient design for converting this rotational kinetic energy to electrical energy. I plan to perform an experimental feasibility study from a simple prototype generator in order to charge a commercial rechargeable battery. After the feasibility study is completed, a design modification study will be followed for further improving the power efficiency.

Taylor Sheldon, Psychology
"Enculturation, Cultural Maintenance, and Identity in Second-Generation Latino/a and Hispanic Immigrants"
Faculty Mentor: Anne Brodsky
Expected Graduation Date: Spring 2016

People of Latino/a and Hispanic decent are the most prevalent minority group in the U.S. and are projected to double in population size in the next 50 years. This study explores the processes of enculturation, cultural maintenance, and identity in second-generation Latino/a and Hispanic immigrants living in the Baltimore/Washington D.C. area. Enculturation, in this context, is the process by which an individual's family's culture is instilled in second-generation Latino/a and Hispanic immigrants. This includes how an individual's culture of origin has an impact on their values, experiences, and behaviors. There is limited research available on enculturation, specifically concerning second-generation Latino/a and Hispanic immigrants, which makes this research unique. Another process explored is how second-generation Latino/a and Hispanic immigrants choose to identify culturally and how they balance mainstream U.S. culture and their Latino or Hispanic heritage. The analysis is based on 15 semi-structured interviews with second-generation Latino/a and Hispanic immigrants. Overall the aim of this study is to increase understanding of the role of culture and identity in the lives of second-generation Latino/a and Hispanic immigrants.

Matthew Shirley, Chemical, Biochemical, and Environmental Engineering
"Flexible Nucleosides as Potential Ebola Inhibitors"
Faculty Mentor: Katherine Seley-Radtke
Expected Graduation Date: Spring 2017

The Ebola pandemic has brought the virus to the forefront of international concern. Ebola's high capability to evade the body's immune system is the reason it is extremely virulent and deadly. Currently, there is no FDA approved treatment or vaccination for the Ebola virus and with fatality rates fluctuating above 90 percent, a reliable Ebola therapeutic is undeniably necessary. Nucleoside analogues have taken the spotlight as potential antivirals against Ebola; they can function as inhibitors by competing with DNA or RNA, preventing the binding of the natural substrate. Previous studies have shown that the inhibition of the enzyme S-adenosylhomocysteine hydrolase (SAHase) has exhibited activity against Ebola. A compound known to inhibit Ebola through SAHase inhibition is the carbocyclic nucleoside Neplanocin A (NpcA). Our project's specific aim is to synthesize a flexible version of NpcA, termed Flex-NpcA, where the adenine base of NpcA is separated into its imidazole and pyrimidine moieties, connected by a carbon-carbon bond. We hypothesize that base flexibility modifications will allow for increased beneficial interactions that the stiff adenine base fails to form, all while maintaining the aromatic and hydrogen bonding characteristics of NpcA. This may lead to an enhanced SAHase binder, and therefore a more effective inhibitor.

Sadjo Sidikou, Chemical, Biochemical, and Environmental Engineering
"Understanding the Cell-Interactions Mechanisms of Fibroblasts in 3D Cell Culture"
Faculty Mentor: Jennie B. Leach
Expected Graduation: Spring 2017

Two-dimensional cell cultures have provided valuable insight into cell-material as well as cell-cell interactions, but findings support that cells better replicate *in vivo* responses when encapsulated within three-dimensional (3D) culture substrates. While cells have receptor proteins that are able to recognize chemical signals from their extracellular matrix environment (ECM), it is also true that cells are capable of sensing the ECM mechanical properties. Therefore, we propose the use of a synthetic biomaterial, Poly(ethylene glycol) (PEG), which is inert and shown to be biocompatible, to study cellular mechanisms from a mechanosensing standpoint. Experimentation has shown that fibroblast encapsulation significantly decreases the swelling capacity of our PEG-based gels. We now seek to further investigate fibroblasts' impact on degradation time and hydrogel stiffness and understand the cellular mechanisms that influence cellular remodeling of the ECM. Though 3D culture substrates have become more common in cell culture, studies using these systems typically overlook how cells alter their extracellular environment and focus on directing cell fate (e.g., proliferation and differentiation). Therefore, this work aims to lay the groundwork for future studies of more complex cell types e.g., neurons and glia) and phenomena (e.g., secretion and/or addition of ECM molecules) in 3D culture.

Jack Slettebak, Computer Science and Electrical Engineering
"Comparing Computing Architectures using the High Performance Conjugate Gradient Benchmark"
Faculty Mentor: Dr. Matthias Gobbert
Expected Graduation: Fall 2015

Parallel algorithms, algorithms that use multiple cores/threads, and architectures sit at the forefront of high performance computing as a means to decrease the execution time of a computationally intense problem. The maya computing cluster at the University of Maryland, Baltimore County (UMBC) High Performance Computing Facility (HPCF) is a machine designed to take advantage of these algorithms and provide a resource for the various researchers who require a powerful computer to solve the problems they encounter in their research. To ensure that the entire system runs at maximum performance, we plan to test each component of the cluster with the newly developed Sandia High Performance Conjugate Gradient (HPCG) benchmark. It is our hope that by using a consistent piece of software we can not only learn more about the computing components themselves, but also construct a comparison between each of them based on their performance.

Natalie Steenrod, Chemistry and Biochemistry
"A Flexible Approach to Treating the Ebola Virus"
Faculty Mentor: Katherine Seley-Radtke
Expected Graduation: Spring 2016

The Ebola virus is at the center of the world's stage due to the recent outbreaks in West Africa. Filoviruses such as Ebola are among the deadliest pathogens known, with fatality rates reaching near 90 percent. Despite dire need, there is no FDA-approved treatment or cure. Presently there are several nucleoside analogues being investigated, including the carbocyclic nucleoside 3-deazaneplanocin A (3-deazaNpcA). The proposed mechanism of action for 3-deazaNpcA is the inhibition of S-adenosylhomocysteine hydrolase (SAHase). Inhibitors of this enzyme indirectly inhibit DNA methyltransferase through a biofeedback mechanism. This halts S-adenosylmethionine-dependent methylations of the 5′-cap of mRNA, leading to defective viral transcription and translation, inhibiting viral replication. For this project, the modified adenine base in 3-deazaNpcA is "split" into its imidazole and pyridine components, remaining connected by a single C-C bond to give the target compound Flex-3-deazaNpcA. This will allow the base to adjust to form non-canonical binding interactions, without losing the integrity of the functional groups required for recognition, hence adopting an optimum conformation within the enzyme binding site. This strategy has been successful in multiple preliminary studies. Thus, endowing the 3-deaza scaffold with flexibility should prove strategic in terms of increased potency against Ebola.

Devin Taylor, Chemistry and Biochemistry
"Synthesis of Multifunctional Gold Nanoparticles for Therapeutic Use"
Faculty Mentor: Marie-Christine Daniel
Expected Graduation: Spring 2016

Cardiovascular disease is the most debilitating disease in the United States; one in three deaths is attributed to this disease. A key molecule that leads to complications often found in cardiovascular disease is Angiotensin Converting Enzyme (ACE). This molecule converts Angiotensin I to Angiotensin II, the latter being a vasoconstrictor whose overexpression often leads to hypertension and heart failure. A common preventative method in combating heart disease is the use of health screenings accommodated with biomarkers, as well as imaging agents. Nanoparticle-targeted imaging systems represent innovative methods that have shown remarkable improvement in combating certain diseases, such as cardiovascular disease. Previous research has shown that gold nanoparticles hold great promise in this field due to their stability and biocompatibility. With this research, the hope is to better combat heart disease by using gold nanoparticles, an ACE inhibitor (lisinopril), and a contrasting MRI agent (DOTA-Gd). After the creation of citrate-coated gold nanoparticles, two ligands will be added onto the surface of the gold core via ligand exchange reaction. The first ligand consists of a spacer molecule linked to lisinopril (TA-TEG-Lis) while the second ligand contains the MRI agent (TA-NHBn-DOTA-Gd). The ultimate goal of the resulting multifunctional gold nanoparticle is to serve as a more effective tracker for cardiovascular disease.

Zachariah Thomas, Music
"Pure Tunings for the Modern Pianist"
Faculty Mentor: Joseph Morin
Expected Graduation: Spring 2016

This research seeks to examine the possibility of incorporating Just tunings into a modern keyboard instrument using auto-tuning digital keyboard technology. Such a development would allow fixed pitch keyboard instruments, e.g., the organ and electric piano, to play music perfectly in tune in any key, freeing these instruments from equal-tempered tuning where every interval can only be tolerably close to in-tune. The research will begin with an evaluation of recent efforts to improve the intonation of keyboard instruments, including current theoretical and practical work regarding dynamic just tuning systems. Next this research will attempt determine the basic 'logic' to be used by a new auto-tuning piano instrument, involving field tests of potential real-time tuning alterations. Finally a concept design for any additional interfaces needed to put the auto-tuning system into action will be developed. All of this will provide a fresh evaluation of modern technology applied to a centuries old tuning problem, might offer pianists and composers with the means to explore previously unavailable clarity and expressivity with the piano, and afford an enhanced experience of great piano literature.

Nicholay Topin, Computer Science and Electrical Engineering
"Value Function Approximation Mapping Creation for Knowledge Transfer"
Faculty Mentor: Marie desJardins
Expected Graduation: Spring 2018

Leveraging existing knowledge is an effective way to reduce the time that it takes a software agent to learn about a new task, or problem domain. Previous methods for using existing knowledge assumed that a direct mapping is known from the source task(s) to the target task. Recent work in identifying a mapping using an unsupervised method has had good results, but used a naive representation of task environments that is not scalable to large, complex, or continuous tasks. I propose to modify these methods to instead use a value function approximation (VFA), a richer representation that supports generalization across regions of the task environment, and that therefore enables scalability to more realistic tasks. The VFA representation will be applied in the context of Portable Option Discovery (POD), a learning transfer method that I developed in collaboration with my mentor and other students. Two possible bases, a radial basis VFA and a polynomial basis VFA, which use different methods of generalization, will be examined. The nature of these two representations reduces the computational complexity of existing processes, allowing further research into alternate heuristics and more exhaustive sampling for the purposes of discovering mappings. The newly created method will be compared to existing methods of policy transfer that do not use mapping discovery and existing methods that do discover a mapping.

Michael Valerino, Chemical, Biochemical, and Environmental Engineering
"Analysis of Aerosol Sources, Transport, and Mixing to Improve Satellite Readings of Ground-Level Particulate Matter"
Faculty Mentor: Christopher Hennigan
Expected Graduation: Spring 2016

During the summer of 2014, the Hennigan lab was part of DISCOVER AQ (Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality), a NASA-funded mission to improve satellite measurements of ground-level air pollution. Many current remote sensing measurements fail to differentiate between pollution in the upper atmosphere and ground level concentrations, motivating the DISCOVER-AQ campaign. From 14 July – 10 August 2014, measurements of inorganic aerosol composition (Na+, NH4+, K+, Mg2+, Ca2+, Cl-, NO3-, and SO42-) and organic carbon (OC) and elemental carbon (EC) were carried out in Golden, Colorado. To improve satellite measurement of aerosol pollution, an integrated approach to analysing sources, mixing, and transport of atmospheric aerosols will be implemented. The ground based measurements will be linked with aircraft and satellite measurements to gain a comprehensive characterization of the processes and sources that most strongly affected air quality in Denver during DISCOVER-AQ. This will include, for example, analysis of the extensive oil and gas exploration activities on aerosol levels in and around Denver. Early results show strong diurnal profiles of EC, NH4+, and NO3-. These results are indicative of local sources and formation of pollutants while other species such as SO42- and OC show no diurnal variance, suggesting they are regional in nature. Further analyses will include spatial distributions of total particulate matter (PM), and the effect of boundary layer evolution on ground level concentrations.

Michael Wolfe, Physics
"Entanglement Dynamics of Inductively Coupled Singlet-Triplet Qubit"
Faculty Mentor: Jason Kestner
Expected Graduation: Spring 2017

A quantum computer has the ability to solve certain problems exponentially faster than a classical computer at the expense of rigorously challenging manipulation of quantum bits (qubits). Recent advances in solid state physics have improved the fabrication of spin qubits by confining electrons in a 2D Fermi gas of Gallium Arsenide- Aluminium Gallium Arsenide heterostructures (i.e. quantum dots). These qubits entangle electrostatically but suffer decoherence due to external coupling to nuclear spins thus limiting the time for logical controlled NOT operations to take place. We investigate alternative coupling methods for two qubits such that their interaction is amplified. For example, two qubits can be entangled at distances on the order of microns via a floating metallic gate that mediates their electrostatic interaction (i.e. capacitive coupling). We theoretically examine how the entanglement dynamics of the system are affected by stray inductance in the floating gate when the qubit's charge configurations are driven at high frequencies.

Rachel Wolven, Visual Arts
"Light Inhibits Light"
Faculty Mentor: Steven Silberg
Expected Graduation: Spring 2016

It's always there and always has been; yet, even as we learn more about it, what we can see with our own eyes is fading. As population grows and society expands, the night becomes an ever fading natural resource. Where the sky was once dark and filled with countless sparkling points of light, we now have an ever glowing orange sky where only the brightest stars and planets are visible. Light pollution is a real problem. Not only does it cause issues in the environment, it also is a waste of energy. All of the light that is going up into the atmosphere is light that was meant to be directed downwards. This summer, I plan to travel the Northeastern US and into Nova Scotia, documenting our dark skies through time lapse photography and measuring amounts of light pollution throughout to showcase the beauty and wonder of our night sky through video in hopes of awakening people to the problem of light pollution.

Abigail Worgul, Ancient Studies
"Temples of Vesta: Their Shape and Socioreligous Function"
Faculty Mentors: Dr. David Rosenbloom and Dr. Melissa Bailey
Expected Graduation: Fall 2016

My research will investigate why the two securely identified ancient Roman temples of Vesta, goddess of the hearth, are built on circular bases rather than on rectangular bases—the shape of the overwhelming majority of Roman temples. Some modern scholars trace the shape back to primitive Etruscan huts. Others emphasize the link between the shape of Vesta's shrines and Greek communal hearths housed in circular structures. The Roman poet Ovid explains that the shape is a representation of the earth in space, which he considered a sphere with fire burning at its center. I will evaluate the religious and social meaning behind the circularity of these temples by personally visiting the remains of the House of Vesta in the Roman Forum and the Temple of Vesta in Tivoli. When I am there I will map these temples in relation to the structures and landscapes surrounding them. By observing how these temples function symbolically within their landscapes, and juxtaposing these observations with my archaeological and textual research into the cult of Vesta, I will be able to offer an argument for why the temples were circular.

Aviva Zapinsky, Biological Sciences
"*Ribosomal Biosynthesis after Repression of Specific Ribosomal Protein Genes*"
Faculty Mentor: Lasse Lindahl
Expected Graduation: Spring 2017

Composed primarily of rRNA, ribosomes also contain ribosomal proteins as an integral part of their structure. Ribosomes synthesize proteins, translating the mRNA sequence into amino acid chains. Ribosomal proteins are themselves translated in the cytoplasm and then transported into the nucleus – to the region known as the nucleolus, where they are incorporated into the ribosomal structures by binding to the rRNA. The synthesis of the two ribosomal subunits requires production of rRNA, 79 ribosomal proteins, and about 200 assembly factors. Disruption of the synthesis of any components leads to nucleolar stress, where the ribosome assembly becomes unsuccessful and the cell cycle gets interrupted. Using yeast as a model organism, I want to determine how the repression of one of the ribosomal proteins affects the fate of ribosomal proteins that are synthesized. I am studying whether during the repression of specific ribosomal proteins other ribosomal proteins are still transported to the nucleus, or whether they remain in the cytoplasm. If the transport of ribosomal proteins remains functional, I would like to determine whether the ribosomal proteins are incorporated into the ribosomal particles and whether these incomplete ribosomal particles are exported to the cytoplasm. Using a yeast strain in which the ribosomal protein L43 is expressed under a galactose promoter and therefore repressed when grown in glucose media, I inserted a GFP-tagged L25 gene under the control of an inducible beta-estradiol promoter. The GFP-tagged L25 protein can be differentiated from the native L25 that is being expressed constitutively. Thus, I can follow the L25-GFP that was induced after the repression of L43 by microscopy and determine whether it does get transported into the nucleus and out again. Incorporation of the tagged protein can be determined by sucrose gradient centrifugation and Western analysis of the gradient fractions. These studies will lead to a greater understanding of the stress response, and the connection between nucleolar stress and the cell cycle.