15th Annual Math and Science Symposium

THE INGENUITY PROJECT

Baltimore Polytechnic Institute

May 25, 2017

Dear Guests and Supporters,

Tonight's 15th Annual Math and Science Symposium is the culmination of hard work by Baltimore's bright future leaders. Between freshman and senior years, students grow dramatically in knowledge and skills, as they prepare to become the next generation of STEM leaders in Baltimore City. You will be amazed at how well the young men and women communicate complex concepts with sophistication and confidence.

I would also like to take this opportunity to recognize a truly special teacher. It was 20 years ago that Dr. Mikhail Goldenberg taught his first class of Ingenuity students at Poly. In the year prior to his start, he met with a group of Ingenuity middle school students whose gifted abilities and hunger to learn inspired him to develop a deep, rigorous math sequence that has since benefitted a generation of students. Dr. Goldenberg has prepared more than 40 students to achieve a perfect score of 800 on the SAT or SAT II math exams, and has helped more than 20 students gain admission to Johns Hopkins University's Future Scholars Math Program, a highly selective opportunity for high school seniors to take math classes at Hopkins. Each year, Dr. Goldenberg also coaches a team of students for math competitions that consistently ranks at the top in Maryland. All of us at Ingenuity are forever grateful to Dr. Goldenberg for his dedication and service.

Further, I want to thank our teachers, parents, and financial supporters who have helped maintain Ingenuity as the longest-standing advanced STEM program in Baltimore City. The Ingenuity Project continues to strive to ensure that Baltimore has a strong, long-term future through an investment in talented and motivated youth.

Join me tonight in learning from Baltimore's next generation of STEM leaders.

Sincerely,

Lisette Morris

Executive Director

High School Program

Baltimore Polytechnic Institute

Baltimore Polytechnic Institute, founded in 1883, has maintained a standard of excellence for over 120 years and is a Blue Ribbon School of Excellence. Founded as a technical (engineering) school, Poly gives students an advanced education in mathematics and science. Poly students consistently maintain standardized test scores above state and national averages. The Poly faculty is comprised of highly qualified individuals who provide valuable insight into the subjects they teach. They work beyond the regular school hours running sports, clubs, and other extracurricular activities. Not only are the students and faculty among the best in the state, but the Poly Alumni Association is also of the highest caliber. Alumni invest countless hours and dollars in support of Poly, keeping the school strong. Jacqueline Williams, class of 1983, has been the director of Poly for four years and has done an exceptional job in bringing great heart and vision to this already prestigious school.

The Ingenuity Project®

A seven-year program for capable and motivated students who excel in mathematics and science, the Ingenuity Project at Baltimore Polytechnic Institute began in 1997. In conjunction with fast-paced, content-rich mathematics and science classes taught by experienced teachers, research is emphasized through classroom activities and off-campus opportunities. Many students begin the program in one of the Ingenuity Projects three middle school programs prior to attending high school.

To qualify for and remain in the Project, Ingenuity students must have excellent attendance and attain an 80% average or higher in all coursework, including summer programs. Students are expected to maintain a demeanor that is respectful of others and reflects the importance of their school work.

Ingenuity Project Overview

Research Program

The Ingenuity Research Curriculum is a three-year program spanning sophomore to senior year, serving as an incubator for future scientists, engineers and mathematicians. During the Research Practicum experience, students work with mentors at local colleges, universities, and other research institutions to develop independent research projects. Students contribute to the body of research and, in some cases, have their work acknowledged in scientific papers. They are required to submit their work to national pre-college competitions. For some, this will mean entering the Siemens Competition and the Regeneron (formerly Intel) Science Talent Search, two of the nation's most prestigious and financially rewarding contests. Juniors and seniors submit their research to local science fairs as well. Almost every year, one to two students receive first place category awards at the Baltimore Science Fair qualifying them to compete to the Intel International Science and Engineering Fair with 1,800 students from over 75 countries.

Mathematics Program

The Ingenuity Mathematics Program has been designed by master mathematician Dr. Mikhail Goldenberg. He uses a variety of textbooks and selects topics that enable students to go into unusual depth in their understanding of the beauty of mathematics, while also enjoying the challenge that problem solving represents.

Incoming ninth grade students must take an Algebra I entrance examination and pass with at least an 80%. Those who do not score an 80% are required to complete an Ingenuity summer algebra course, and have the opportunity to take the examination again. Ninth grade students complete a year of Geometry; tenth grade students complete a year of Algebra II, and a semester each of Trigonometry and Probability/Statistics. The majority of eleventh grade students complete Advanced Placement Calculus (AB), with the option of taking the AP examination at the end of their junior year. After studying advanced topics in calculus as seniors, many students take the AP Calculus (BC) examination. Students with extraordinary aptitude may take accelerated classes, and some work independently with Dr. Goldenberg. Several students have also qualified to take classes at Johns Hopkins University.

Student success is documented through many mathematics competitions such as Maryland Math League, the American Mathematics Competitions, American Invitational Mathematics Examination and the University of Maryland High School Mathematics Competition.

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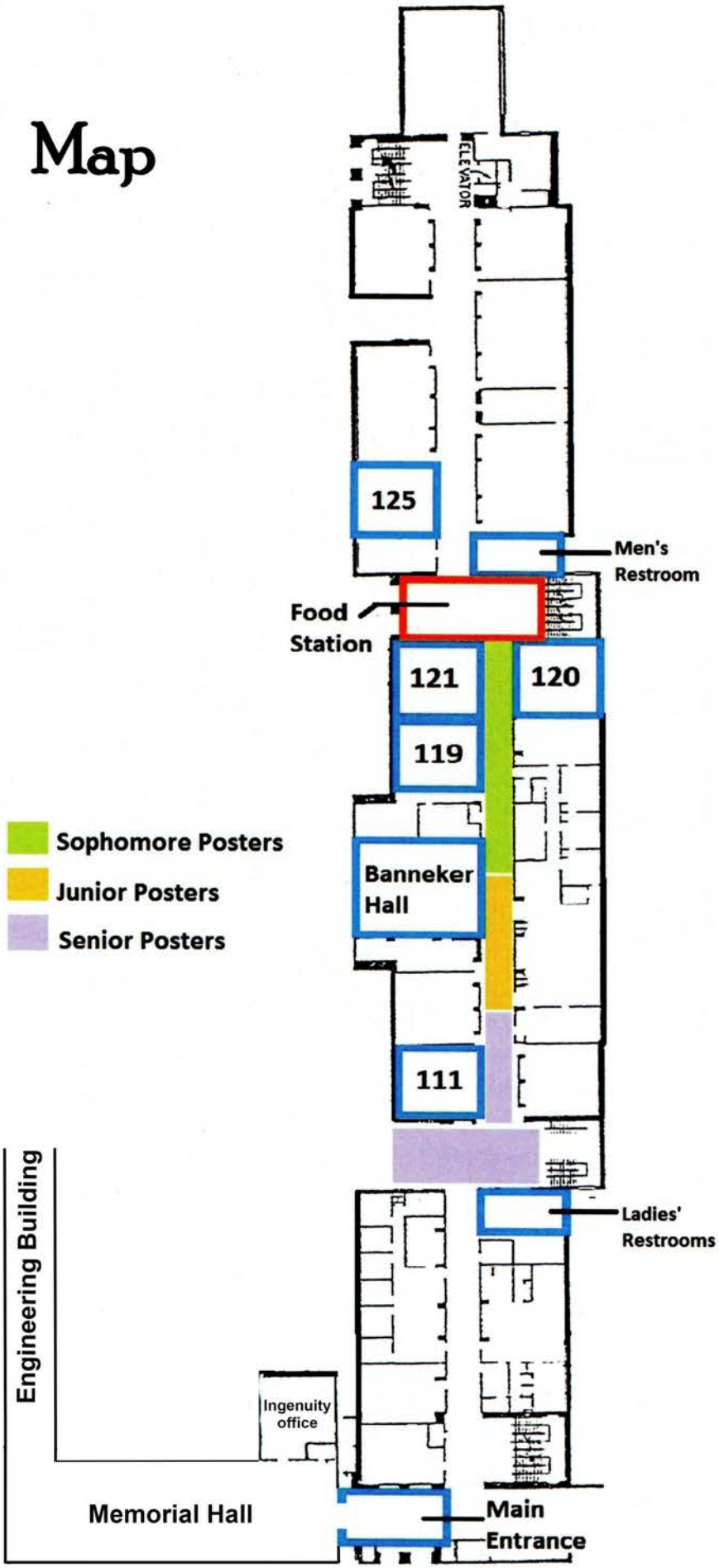
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Schedule

5:00-6:00 Poster Viewing and Refreshments
6:00-6:25 Opening Comments- **Banneker Hall**
MCs: Robert Henry and Sophia Hager

PRESENTATIONS

6:30-6:45

Banneker Hall	Self-Folding Motile Encapsulating Microdevices For Use in Single-Cell Analysis — ***Amy Zhang***
Room 119	Counterexamples in Calculus — ***Emma Eklund and Lauren Fink***
Room 120	Visualization of Aurora Kinase A Activity through Development of a FRET Biosensor — ***Yoav Kargon***
Room 121	Steiner Ellipse — ***Sigurdur "Ben" Bjarnson and Aishwarya Shettigar***
Room 125	Effects of Resistance to Inhibitors of the ERK 1/2 Pathway in BRAF Mutated Melanoma Cells — ***Anisa Hofert***

6:55-7:10

Banneker Hall	*Dethiosulfovibrio Strain F2b,* a New Non-Thiosulfate Reducing Bacterium that Degrades Mariculture Waste — ***Stephen Grabowski***
Room 119	The Effects of Varying Water Temperature and Salinity Incubation on the Movement and Reproduction of Zebrafish — ***Julianna Lucas***
Room 120	Evaluation of Cribriform Foramina in Relation to Dietary Habits of Various Species within *Lemuroidea* — ***Olivia Birkel***
Room 121	Some Theorems and Problems in 3D Geometry — ***Nick Eusman and Robin Graham-Hayes***
Room 125	Fecal Sampling of Corticosterone in Chronic Unpredictable Mild Stress in Mice — ***Jacob Smith***

7:20- 7:35

Banneker Hall	Studying Toxigenic *C. difficile* as a Potential Inducer of Colon Cancer — ***Aishwarya Shettigar***
Room 119	A Comparison of Stock Data and Randomly Generated Data in the Context of Support and Resistance — ***Sigurdur "Ben" Bjarnson***
Room 120	Pulse Responses During Sleep Disordered Breathing Episodes — ***Branden Etienne***
Room 121	Transcendental Numbers Exist! — ***Andrew Frock and Amy Zhang***
Room 125	Diffusion Tensor Imaging in Monitoring Nerve Regeneration through Axogen Nerve Grafts in Rats — ***Sydney Worsham***

7:45- 8:00

Banneker Hall	Evaluating "Difficult" Integrals — ***Yoav Kargon and Sam Smith***
Room 119	Data Analysis of the NFL and MLB in Regards to Host Cities—***Sydney Rosebrough***
Room 120	A Compliance Model to Improve the Accuracy of the da Vinci Research Kit — ***Nick Eusman***
Room 121	Solving Second Order Linear and Non-Linear Ordinary Differential Equations — ***Stephen Grabowski***
Room 125	Inspiring the next generation of STEM Leaders through the Senior Research Service Learning Project at Eutaw-Marshburn Elementary School — ***Jasmine Long***

AWARDS CEREMONY

8:05-8:45 **Banneker Hall**
MCs: Claire Wayner, Moufie Adedoyin, and ShinShin Erdas

About the Keynote

Dr. Charles Johnson-Bey

Director, Engineering & Technology, Cyber Solutions

Lockheed Martin Corporation, Baltimore, Maryland

Dr. Johnson-Bey graduated from the **Baltimore Polytechnic Institute**. He has a BS degree in Electrical & Computer Engineering from the Johns Hopkins University and both his Masters and Ph.D. degrees in Electrical Engineering from the University of Delaware.

Dr. Charles Johnson-Bey has experience in designing and executing projects that leverage the intersection of technology, strategy, and business to create value and new opportunities. His expertise has spanned the commercial industry, the defense industry, and academia.

Currently, he works for Lockheed Martin Corporation with increasing levels of responsibility in advanced technology and strategy. Currently, as the Director of Engineering & Technology at Lockheed Martin Corporation, he leads a variety of strategic projects to support the growth and value creation objectives of the Cyber Solutions organization. Technologies include everything from cyber forensics and analytics to advanced platforms.

Prior to this role, he was the Senior Manager and Baltimore Site Lead for Engineering and Technology of Lockheed Martin Corporation. In this capacity, he manages multiple engineering disciplines including Systems, Electrical, Mechanical, and Software through subordinate managers. He also leads technical teams and manages both strategic and tactical applications for the organization.

Throughout his career, Dr. Johnson-Bey has led several critical initiatives for Lockheed Martin Corporation, including Principal Technology Strategist. He was responsible for research and product development encompassing multiple engineering disciplines, such as naval, biomedical, electrical, and composite technology. Dr. Johnson-Bey was also one of the leaders of Lockheed's Corporate Small Business Innovative Research Working Group which coordinated process, technology identification and utilization of small business technologies across all of Lockheed's Business Areas.

Senior Research Abstracts

The seniors' presentations represent the culmination of their research efforts. Students completing Ingenuity Research Practicum with Mrs. Lisa Fridman worked with members of the scientific community for fifteen months beginning the summer prior to their junior year. Each student has written a formal research paper detailing the results of his or her respective project. The papers were submitted to national pre-college competitions, including Siemens Competition, Regeneron Science Talent Search, and Maryland Junior Science and Humanities Symposium. (Note: some Ingenuity students elect to take Poly's Research Practicum during their senior year.)

Front Row (from left to right): Sydney Worsham, Yoav Kargon, Aishwarya Shettigar, Jasmine Long, Jacob Smith, Samantha Niziolek, Julianna Lucas, Anisa Hofert

Middle Row(from left to right): Olivia Birkel, Amy Zhang, Sam Smith, Sydney Rosebrough, Nick Eusman, Emma Eklund

Back Row (from left to right): Branden Etienne, Andrew Frock, Sigurdur "Ben" Bjarnson, Robin Graham-Hayes, Stephen Grabowski

Senior Research Abstracts

Evaluation of Cribriform Foramina in Relation to Dietary Habits of Various Species within *Lemuroidea*

Olivia Birkel

Mentor: Dr. Jonathan Perry
Institution: Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine

The cribriform plate is a groove located in the anterior of the skull which houses the olfactory bulb and olfactory nerves. The olfactory nerves pass through the cribriform foramina, small holes in the plate, that allow the nerves to connect to the brain. Olfactory nerves transmit signals to the brain, so that odors can then be identified and connected to a certain entity. Organisms that retain a heightened sense of smell have an increased number and size of olfactory nerves to accommodate the increasing complexity of their olfactory system. Previous data collection studies on primate adaptations suggest that the size of the olfactory nerves may be affected by habitat and reliance on certain sensory areas. For this project, twenty-eight DICOM and CT scans from eight different lemur species were obtained in order to analyze the connection of various preferred diets of species from *Lemuroidea* and the varying size of their corresponding foramina. Cribriform foramina from these multiple species of primates were measured using skeletal models and 3D imaging and processing software. This experiment is being used to analyze the connection between the various preferred diets of species from *Lemuroidea* and the varying size of their corresponding foramina. It was found that the size and number of the foramina do increase as the difficulty of locating a food source increases and there is variation between species; however, even though the data does support this conclusion, there is weak statistical support due to the small sample size.

A Comparison of Stock Data and Randomly Generated Data in the Context of Support and Resistance

Sigurdur “Ben” Bjarnason

Mentor: Dr. Daniel Q Naiman
Institution: Department of Applied Mathematics and Statistics, Johns Hopkins University

There are two general sections of investors involved in the stock market. Fundamental analysts work to find the underlying value of a business with hopes to make relatively long term gains. Technical analysis looks towards previous prices in order to predict future price movements. There are disputes over the effectiveness of technical analysis because of the Random Walk Hypothesis, which says that predictable patterns based on historical prices cannot exist in the market. If a pattern emerges, the hypothesis says, it is strictly an outcome of probability and has no meaning in terms of a market. One technical analysis technique is support and resistance, the idea that once stock prices reach a high point in movement, a reversal is likely to happen at that price in the future. The Random Walk Hypothesis would suggest that there’s an equal number of support and resistance based reversals in a dataset made of random price movements and one of stock data. To test that hypothesis, a comparison is done between the datasets regarding the frequency of support and resistance related reversals. The finding is that there is no statistically significant difference between historical stock data and randomly generated data.

Mapping and Explaining Baltimore's Urban Heat Island

Emma Eklund

Mentor: Dr. Benjamin Zaitchik
Institution: Department of Earth and Planetary Sciences, Johns Hopkins University

The urban heat island effect is an anthropogenic phenomenon where the temperature in an urban area is higher than in a rural one. Baltimore's urban heat island (UHI) was mapped using satellite images. The Landsat 8 satellite contains thermal infrared data from Band 10, which measures the temperature of the ground. LST was found by using data from Landsat 8, and then using multiple equations for corrections. These corrections were done for five consecutive months (July, August, September, October, November) in order to create a time variation. These results showed that the intensity of the UHI was greatest in July and August, and then decreased as the months proceeded. This would suggest that the UHI has greatest intensity during the summer, and varies monthly. Conditionals were completed to analyze how human industrialized areas affect the temperature, which increased the R^2 values in the regressions.

Pulse Responses During Sleep Disordered Breathing Episodes

Branden Etienne

Mentor: Dr. Luu Van Pham
Institution: Johns Hopkins University, Bayview Campus

Sleep apnea is a very common sleep disorder that is associated with a variety of other diseases. There are two types of apnea: central, and obstructive sleep apnea. Obstructive apnea is prevalent in people with lots of fat around their neck, or have some other obstruction of the airway in the throat. Therefore, mostly people who are overweight or have breathing problems tend to have sleep apnea. While sleep apnea is fairly well studied in normal environments, high altitude conditions are not as well studied. Thus, a cohort was formed specifically to assist in identifying hypoxemia and cardiovascular responses in people living at higher altitudes in order to develop treatments to assist them. A previous study in the same lab collected data from these test subjects during a sleep study and the data was collected using an ApneaLink. We decided to analyze these subjects' pulses from the sleep data recorded to see if there was an association between pulse to the type of apnea a subject has. A tool programmed in R language has also been developed to compare different methods of calculating pulse between our tool and ApneaLink. The difference between our tool and the Apnealink was that the ApneaLink used calculated the pulse using a windowed average and there was some time before changes in pulse were accurately portrayed. Our tool would calculate pulse at specific times. However, our tool ran into the problem of the physiology behind sleep apnea events; events that happened in rapid succession would inflate the pulse of the subject during an apnea event and make it difficult to determine whether the change in pulse occurred because of the current apnea event or the previous apnea event; because of this we settled on using the ApneaLink to calculate the pulse. Our research has found that there is not an association between pulse and/or pulse change to the type of apnea occurring.

Senior Research Abstracts

A Compliance Model to Improve the Accuracy of the da Vinci Research Kit

Nick Eusman

Mentor: Dr. Peter Kazanzides
Institute: SMARTS Lab, Johns Hopkins University, Hackerman Hall

The da Vinci surgical robot is widely used for minimally-invasive surgery. It inserts multiple articulated instruments through small incisions into the patient. The robot system contains encoders to measure joint displacements which, when combined with the kinematic model of the robot, measures the instrument position and orientation. But, the accuracy of these measurements is affected by non-kinematic errors, such as bending of the instruments due to applied loads. With the help of my lab, I developed a compliance model that relates displacement of the first two joints of the da Vinci Patient Side Manipulator (PSM) to lateral forces applied to the instrument shaft. This model enables us to compensate for these errors based on the measured joint efforts, which are derived from the measured motor currents. We performed experiments with the open-source da Vinci Research Kit (dVRK) to estimate the model parameters and to evaluate the accuracy improvement that results from application of this model. Preliminary results indicate that the model-based correction can reduce instrument position error due to externally-applied forces by a factor of 2 to 3.

Construction of an Electrospray Ionization Source

Andrew Frock

Mentor: Dr. Kit Bowen
Institution: Bowen Lab JHU

Photoelectron spectrometry is a technique used to study many properties of atoms and molecules, including oxidation states, isotopes, and structure. To be studied with this technique, the compound must be an ion in the gas phase. Electrospray is a technique to reliably transfer a dissolved ion into the gas phase. A solution of the ion is sent through a charged capillary tube to remove the undesired conjugate ion, and is then ejected into a chamber under vacuum. Coulombic explosions break the solution into tiny droplets, which are heated to remove the solvent. The goal of this project was to construct an instrument that allows for the collection of photoelectron spectra from compounds that are difficult to grow as crystals or to vaporize without decomposition, including complex organic molecules.

Dethiosulfovibrio Strain F2b, a New Non-Thiosulfate Reducing Bacterium that Degrades Mariculture Waste

Stephen F. Grabowski

Mentor: Dr. Kevin R. Sowers
Institution: The Institute of Marine and Environmental Technology (IMET)/University of Maryland, Baltimore County (UMBC)

Growth conditions of *Dethiosulfovibrio* strain F2b, a new fermentative marine bacterium recently isolated from protein-rich mariculture waste, are described, and applications to sustainable aquaculture are discussed. Motile, vibrioid cells of 2-7 μm in length and 1-2 μm in diameter were observed. Growth occurred at 20°C-40°C, pH 6.5-8.0, and NaCl 0.0-1.6 M with optimum at 30°C, pH 7.5, and NaCl 0.4 M. Peptides and casamino acids were utilized. Yeast extract was necessary for growth on fatty acids or single amino acids. G+C DNA base composition was 49.9%, and DNA hybridization with other strains of *Dethiosulfovibrio* has yet to be carried out. Neither thiosulfate nor elemental sulfur was reduced to sulfide, which has significant implications for the degradation of fish waste. On the basis of significant metabolic and genetic differences from other organisms, strain F2b is suspected to represent a new species.

Design of a Modular Linear Magnetic Encoder For Use in Self-Replicating Robot

Robin Graham-Hayes

Mentor: Dr. Greg Chirikjian
Institute: Robotics and Protein Kinematics Laboratory, JHU

I developed and tested a magnetic linear encoder as a back-up sensory system for a self-replicating robot. This encoder uses peaks of magnetic interference to detect distance changes and relay relative distance moved by the robotic system in order for the robot to know its position and make sure that it is not experiencing any physical errors where the robot would entangle itself or become dislodged from the track. This allows the robot to detect those problems and potentially deal with them. This new encoder allows for modular expansion to the theoretically infinite level. This is so that each piece can continue to expand and maintain knowledge of its movement as it moves along and places the new modules.

Senior Research Abstracts

Effects of Resistance to Inhibitors of the ERK 1/2 Pathway in BRAF Mutated Melanoma Cells

Anisa Hofert

Mentor: Dr. Paul Shapiro
Institution: School of Pharmacy, University of Maryland

Cancer develops when a cell mutates and is not able to control proliferation. Proliferation is controlled by a signal transduction pathway using a kinase cascade. The pathway that controls proliferation in melanoma cells begins with the RTK protein followed by the phosphorylation of BRaf, MEK, and ERK proteins. Melanoma cell types with BRaf mutations are being studied to understand their resistance to drugs that inhibit different steps in the proliferation pathway. The BRaf mutation stops the negative feedback reaction that would ordinarily suppress the production of new cells. Drugs such as PLX, a BRaf inhibitor, AZD, a MEK inhibitor, and GDC/ PLX, ERK inhibitors are able to stop the pathway manually, but a resistance to the drugs is developed. Due to confirmed resistance to these inhibitors, the study looked for different proteins unregulated in the resistant cells. Once resistance was determined, another specific protein was chosen to study called Nicotinamide N-Methyltransferase (NNMT). This protein changes the methylation landscape of the DNA, increasing the chance of metastasis. It was found that NNMT was up-regulated in AZD and GDC resistant cells. Microscopy data showed a slight increase in tubulin which indicates metastasis as well, but there was not enough data for a definite conclusion.

Gene Expression Change in Triple Negative Breast Cancer Cells when treated with CB839

Jasmine Long

Mentor: Dr. Saraswati Sukumar
Institution: Sidney Kimmel Comprehensive Cancer Center, Johns Hopkins University

Breast cancer can be divided into subsections that have different prognostic and therapeutic implications. Breast cancer patients regularly have their expression of estrogen receptor (ER), progesterone receptor (PR), and amplification of HER-2/Neu evaluated. The expression and amplification act as markers, allowing the classification of breast cancer tumors as hormone receptor positive tumors, HER-2/Neu amplified tumors, or tumors which do not express ER, do not express PR, and do not have HER-2/Neu amplification. The group that does not express ER, does not express PR, and does not have HER-2/Neu amplification is referred to as triple-negative breast cancer (TNBC) based on the lack of these three molecular markers. Early and advanced staged TNBC tumors are treated predominantly with chemotherapy. Given the lack of validated molecular targets and the poor outcome in patients with TNBC, there is a clear need for a greater understanding of TNBC at all levels, as well as the development of better therapies. CB-839 is a potent, selective, and orally bioavailable inhibitor of both splice variants of glutaminase (KGA and GAC). TNBC cells are glutamine dependent and when treated CB-839, anti-proliferation was seen. I looked into the effect the drug CB-839 has on TNBC gene expression to gain a better understanding of TNBC cells and determine better treatment options.

Visualization of Aurora Kinase A Activity through Development of a FRET Biosensor

Yoav Kargon

Mentor: Dr. Takanari Inoue
Institution: Cell Biology Department, Johns Hopkins University School of Medicine

Aurora kinase A (Aurora A) is an enzyme involved in mitosis and meiosis and is necessary for proper cell reproduction. Issues with the expression of Aurora A have been connected to cancerous cells; previous studies have shown irregular overexpression of Aurora A in breast cancer tumors. The enzyme has also been implicated in ciliary disassembly. To study the role of Aurora A in mammalian cells, a fluorescence sensor based on Fluorescence Resonance Energy Transfer (FRET) is being developed. FRET occurs when two fluorophores are within a small distance of each other and can be used to measure proximity of proteins tagged with the fluorescent sensors. The design of the sensor is based on an intramolecular FRET backbone reported to facilitate creation and optimization of such biosensors. As of now, each iteration of the sensor, designed based on the substrates of the Aurora A enzyme, failed to produce a measureable signal when expressed and stimulated in cells. The creation of the Aurora A sensor would allow further research into the enzyme's role in the cell by providing real-time visualization through time-lapse fluorescent microscopy of the enzyme's activity in living cells. The data and findings presented in this project have progressed the continuing development of a sensor with this goal in mind.

The Effects of Varying Water Temperature and Salinity Incubation on the Movement and Reproduction of Zebrafish

Julianna Lucas

Mentor: Dr. Yonathan Zohar
Institution: Institute of Marine and Environmental Technology

Climate change is shifting water conditions in the world's waterways and oceans, which may be affecting many fish species negatively. Two conditions that climate change is affecting are water temperature and salinity. I was interested in finding the impacts of raising fish in higher and lower than ideal temperatures, as well as the impacts of higher salinities on zebrafish. The specific functions being studied are the amount of movement and the reproductive capabilities. I incubated zebrafish eggs in temperatures and salinities at and varying from ideal conditions. The fish were placed in a DanioVision tracker at the larval stage to measure the amount of distance moved when both incubated and tested in different conditions of temperature and salinity. Fish incubated in temperatures higher than ideal and control temperatures were spawned to gather information on the comparative egg production. Some trends showed that fish incubated in higher and lower than ideal temperatures were more sluggish, as compared to ideal temperature fish. There were minimal trends in the spawning data collected on the fish raised in high and ideal temperatures. I found some evidence supporting the dangers of climate change on fish; however, more research is required on the topic.

Senior Research Abstracts

Characterizing Motion and Form Perception in *Mustela putorius furo*

Samantha Niziolek

Mentor: Dr. Kristina Nielsen
Institution: Department of Neuroscience, Johns Hopkins Mind and Brain Institute

The visual cortex is very complex and requires several parts of the brain to generate a complete picture of the world we experience everyday. Specialized components each individually take into account color, texture, form, orientation, depth and motion. Motion perception in humans is processed chiefly by the V4, and form is processed by the V5 and posterior regions. We can quantify both motion and form perception by running behavioral tasks in which stimuli are presented with varying coherence levels and a test subject is asked to respond. Creating psychometric graphs of this data allows us to obtain threshold measurements, which are useful when compared to structural and functional observations collected in the same subject. By comparing behavioral studies with physiological data we can better understand the function of these specialized components. This will help create a better understanding of developmental disorders, as well as unique disabilities such as akinetopsia, ultimately helping with treatment.

Data Analysis of the NFL and MLB in Regards to Host Cities

Sydney Rosebrough

Mentor: Dr. Dan Naiman
Institution: Department of Applied Mathematics and Statistics Department, Johns Hopkins University

Data analytics is the practice of drawing conclusions based off a set of information. There are many branches of analytics that focus on specific topics, such as sports. Data analytics allows data to be analyzed not just on a historical basis, but also from a pure numerical standpoint. The purpose of this project is to observe trends between sports and the general public. The National Football League (NFL) is comprised of two divisions: the American Football Conference (AFC) and the National Football Conference (NFC). I used teams from the AFC division of the NFL, whose home city is also home to a baseball team that is a part of the Major League Baseball (MLB) organization. I used data provided by the NFL, MLB, and other public sources to conduct analysis, such as the overall performance scores (PCT), ticket prices, and the cost of living in each city. I used the programming software Rstudio and Python. I have found evidence that supports the claim that there is a greater attendance for teams in the MLB when the team is having a winning season, compared to teams in the NFL whose attendance does not have a strong correlation with game performance.

Studying Toxigenic *C. difficile* as a Potential Inducer of Colon Cancer

Aishwarya Shettigar

Mentor: Dr. Cynthia Sears
Institution: Department of Oncology, Johns Hopkins University

An abnormal microbiota has increasingly been associated with the onset of diseases such as inflammatory bowel disease (IBD) and colorectal cancer (CRC). One possible mechanism through which these gut microbes induce disease is through biofilms, aggregations of cells that infiltrate the mucosal layer adhered to intestinal epithelial cells. The direct contact between bacteria and human cells is hypothesized to induce a breakdown in cell junctions, and thus activate various immune responses. Sequencing of biofilms found in biopsies from CRC tumor and normal tissue surrounding the tumor (flanking tissue) has shown abnormally high populations of *Clostridium difficile* (Cd). This bacterium is a widely known inducer of colitis and diarrhea; however, no direct link between Cd and colon cancer has been established. This study aimed to investigate whether pathogenic bacteria are present in these biofilms and the effect they can have on the human body. Stool from germ-free mice inoculated with human biofilms were used to extract possible pathogenic Cd colonies, and positively identified toxigenic Cd was found in the inoculated mice. Further experimentation using cell toxicity assays and re-inoculation into mice may reveal pathogenic characteristics about this bacterium. A link found between Cd and carcinogenesis would contribute to the growing hypothesis that microbiomes play a role in disease.

Fecal Sampling of Corticosterone in Chronic Unpredictable Mild Stress in Mice

Jacob Smith

Mentor: Dr. Kathleen Gabrielson
Institute: Department of Molecular and Comparative Pathobiology, Johns Hopkins University School of Medicine

The ErbB2 receptor is expressed in breast cancers, but a treatment that blocks ErbB2 has been shown to cause cardiac dysfunction in patients, which may be related to the stress of the patient. Therefore, a chronic unpredictable mild stress (CUMS) model in mice was implemented to use stresses roughly similar to those that breast cancer patients experience. I sought to evaluate the mouse model by measuring corticosterone levels in fecal samples collected from two stress experiments, using the principle of the hypothalamic-pituitary-adrenal axis responding to stress by increasing glucocorticoids, such as corticosterone. The corticosterone was quantified with a competitive corticosterone ELIZA. In addition, fecal samples spiked with a known amount of corticosterone were used to gain more information about the process of measuring fecal corticosterone levels. The results of the spiked samples partially validate the process that the used of measuring fecal corticosterone. Very little difference across the experimental groups of the 1st CUMS experiment was found, which suggests that the animals were not stressed. This could be because the experiment had forced swimming, which has been shown to decrease corticosterone levels in a rat models. The groups in the second experiment seemed to have elevated corticosterone levels compared to the non-CUMS groups, but the CUMS group's corticosterone levels decreased over time. This could be because the animals were getting used to the stress or because the stresses weren't varied enough. This project provided information for the laboratory on how to do the process of fecal analysis of corticosterone in mice.

Senior Research Abstracts

A Tale of Two Proteins

Samuel Smith

Mentor: Dr. Mark Levis
Institution: Department of Oncology, Johns Hopkins Medical Institute

FF10101 is a new Tyrosine Kinase Inhibitor (TKI) designed to inhibit Flt3, a commonly mutated protein in primary acute myeloid leukemia (AML). Through dose response western blots in medium the drug was found to be very potent against Flt3 with an IC50 of .5 nM. FF10101 was found to be less affected, than other TKIs by FL through dose response western blots in which FL, a cytokine that with most drugs decreases potency, was added, to little effect. As Flt3 and C-kit are closely related proteins, and inhibition of C-kit would cause myelosuppression in patients it was decided that the activity of FF10101 against C-kit should be evaluated. The potency was evaluated through a very similar procedure to the one used to evaluate activity against Flt3, and was found to be high, though not as high as the potency against Flt3. Colony formation assay were also performed to test the Drug's effect on healthy hematopoietic progenitor cells, which was also found to be high.

Diffusion Tensor Imaging in Monitoring Nerve Regeneration through Axogen Nerve Grafts in Rats

Sydney Worsham

Mentor: Dr. Daniel Naiman
Institution: Department of Applied Mathematics and Statistics, Johns Hopkins University

The purpose of the present study is to determine whether it is possible to visualize a nerve regenerating using a commercially available nerve graft (Avance, Axogen Inc.) at various states of regrowth. Our hypothesis is that Diffusion Tensor Imaging (DTI) will provide discernible visualization of nerve regeneration through a nerve graft created for clinical use. The methods involve comparing five groups' DTI scans with their histological samples over time to monitor their nerve regeneration. While peripheral nerve damage is not a very common type of nerve injury, presenting visibility of nerve regeneration through a commercial graft would provide proof of concept for a method of continuous, non-invasive evaluation of progress and complications following graft repair.

Self-Folding Motile Encapsulating Microdevices For Use in Single-Cell Analysis

Amy Zhang

Mentor: Dr. David Gracias
Institution: Department of Chemical and Biomolecular Engineering, Johns Hopkins University

Single-cell analysis isolates and studies individual cells to gain a more comprehensive picture of the tissue they come from. The established types of this analysis have certain disadvantages, such as being unable to study cells' dynamic behaviors or study all different kinds of cells. Not only are the established types time-consuming and expensive, they are also passive; they aren't yet connected to the active nature of surgery. To overcome these disadvantages, I developed self-folding encapsulating microdevices attached to magnetic helical tails using the conventional fabrication techniques of MEMS and 3D self-assembly. These microdevices are potentially able to travel to and capture single cells *in vivo* through narrow human passageways with the enhanced mobility provided by the tails. Thus, I developed a new method of relatively inexpensive, high-throughput, and active single-cell analysis without any of the previously mentioned disadvantages that represent the first steps toward microsurgery.

Senior Practicum

The following students elected to take Poly's Research Practicum during their senior year with Ms. Sally Kutzer. They presented their results to a public audience at Poly on May 4, 2017.

Stathmin 2 and Choline Acetyl Transferase Immunoreacting as a Method of Evaluating Nerve Regeneration

Monika Watat

The nervous system is a part of an animal's body that coordinates its voluntary and involuntary actions, as well as transmits signals to and from different parts of the body. Nerves in the peripheral nervous system (PNS) can regenerate while nerves in the central nervous system (CNS) cannot. Although studies have suggested that MCT1 supplies lactate to axons during regeneration, little is known about the pathway for energy supply to peripheral nerves (Halestrap 2013). Studies were conducted using SCG10 and ChAT immunoreactivity to evaluate nerve regeneration between MCT1 heterozygous mice and wild type mice. Initial results, as well as following results indicate no difference in regeneration between wild type ice and MCT1 heterozygous mice. These results are in contrast with previously published works (Lee 2012), which show that lack of MCT1 has negative effects on nerve regeneration.

Long Noncoding RNA Functional Analysis

Martin Orellana

Once thought to be transcriptional byproducts, lncRNAs may have significant roles in diverse cellular processes, including establishing the cellular identity of neural stem cells in mice. We selected 10 previously uncharacterized lncRNAs due to their proximity to genes that control important cell functions and differentiation. Using RT-qPCR, we found the relative transcriptional activity of our targets across a variety of mouse neuronal progenitor cells and neuronal immortal cell lines. Then CRISPR constructs were created to inhibit or activate transcription around the target locus to observe its effects on cell proliferation. We found that the target lncRNA RT-qPCR lead to inconclusive expression for most of the cell types except the N2A cell line.

Regulations Associated with Telemedicine Program at BCHD

Ben Baitman

The telemedicine program run through the Baltimore City Health Department (BCHD) was created to increase access and quality of health care in Baltimore City Public Schools through the use of telemedicine technologies. Much of the development of the Baltimore City program lies in receiving approval from various state agencies who regulate certain aspects that all must be met. There are guidelines that can be taken from grants, program overviews, and other telemedicine projects that provide direction in developing and implementing the program. These are the basis of my work; learning how to meet regulations and drafting documents related to the program. Many of the primary steps have been taken, but some progress has been held back because of disagreements about the aims of the program.

Senior Math Projects

Each of the following mathematics projects was conducted under the supervision of Dr. Mikhail Goldenberg, the Ingenuity math department head. After completing their coursework for the Calculus BC course, the students selected topics for in-depth study and solved a complex problem on that topic.

Counterexamples in Calculus

Emma Eklund and Lauren Fink

Mathematical statements derived from common sense can help solidify a concept to students, but they can be misleading. Theorems and statements in calculus must stem from rigorous definitions and carefully proven theorems. When statements are made on the assertions of common sense, and not rigorous mathematics, these statements may have loopholes that are not apparent at first. The best way to show that a statement is not completely true is to present a situation where the statement is false. While this seems easy, finding these situations is not always simple. That is why this project will explore certain situations, or counterexamples, that disprove a statement that seems to be true. We will cover topics from simple graphs to limits to integrals.

Evaluating "Difficult" Integrals

Yoav Kargon and Sam Smith

By definition, a rational function is the quotient of two polynomials. It can be shown that all proper rational functions can be written as the sum of fractions of four different forms. Three are simple to integrate, but one requires more complex techniques of evaluation. In this project, we will first show that each of these fractions have antiderivatives in the form of polynomials or functions of arctan(x) and ln(x). We will then apply those techniques in evaluating improper integrals that require methods of integration outside of typical calculus work.

Transcendental Numbers Exist!

Andrew Frock and Amy Zhang

Set theory is a branch of abstract mathematics that studies sets, or collections of elements. Sets can be finite, like the letters in the alphabet, or infinite, like integers. Comparing the size of finite sets is intuitive, but it gets more complicated with infinite sets. Some infinite sets are bigger than other infinite sets. How does the size of natural numbers compare to that of integers? The answer is not what you may think. Certain methods are used to compare infinite sets, and we will use these techniques from set theory to prove that a special set of numbers, transcendental numbers, exist.

Solving Second Order Linear and Non-Linear Ordinary Differential Equations

Stephen Grabowski

Differential equations are a broad class of equations that involve information about the rate of change of some function. The main goal of studying differential equations is to solve for the original function in its explicit forms whenever possible, or else to show that a solution exists. This work is often motivated by the application of differential equations to physical phenomena, ranging from heat transfer to biological processes. It can be shown that second order linear equations are solvable generally, with the solutions expressed in terms of integrals of a certain form. Non-linear equations, however, are of particular interest because they are often very complex, and no general method exists for solving them. Nonetheless, this presentation examines specific cases of non-linear equations for which a unique approach can reduce the equation to a simpler, more solvable form.

Some Theorems and Problems in 3D Geometry

Nick Eusman and Robin Graham-Hayes

Stereometry, or three dimensional geometry, is the study of lines, planes, and shapes in space. This subject is based on traditional Euclidian planar geometry, but also uses its own axioms and theorems. In this project, we will develop a few of these theorems, such as the theorem of parallel lines and a plane and the theorem of three perpendiculars. Applying that knowledge, we will also solve some problems about shapes in space. These will include problems such as the "Pythagorean Theorem" in three dimensions. Stereometry has many real world applications ranging from physics to engineering; this presentation hopes to provide a mere introduction to the subject.

Steiner Ellipse

Sigurdur Ben Bjarnson and Aishwarya Shettigar

The Steiner Ellipse is a unique ellipse named for and developed by Swiss mathematician Jakob Steiner. It is circumscribed around a triangle which is constructed using an ellipse and a point on the ellipse. The centroid of the triangle coincides with the center of the ellipse. There are many interesting properties of the Steiner Ellipse and its inscribed triangle. One such property is that the sum of the squares of the sides of the triangle is constant and only dependent on the particular ellipse. The area of the triangle is also constant and dependent on the ellipse. Finally, the Steiner Ellipse is the ellipse of least area circumscribed around a triangle.

Trigonometry in Calculus

Sarah Bowden and Anisa Hofert

Trigonometry, which, at its root, is the study of the relationships between angles and sides of triangles, has a range of applications in calculus. Many identities and relationships can be derived from trigonometric functions. Using trigonometric substitutions in higher level integration can greatly simplify the integrals for evaluation. The presentation will show examples of how trigonometry is commonly used in calculus. The project involves proving many formulas relating to trigonometric expressions, but the focus will be mainly on the substitution of tan(x/2) as Z, also known as the universal substitution. The substitution can easily change complex trigonometric expressions into more basic expressions.

Junior Research Abstracts

The juniors are entering the final phase of their Research Practicum placements. Throughout the previous summer and the current school year they have worked with their mentors on their independent research projects. They will continue their work this summer to complete their projects. The posters on display represent recent progress. Juniors submit their work to local competitions, including the Baltimore Science Fair and Maryland Junior Science and Humanities Symposium. The juniors are also responsible for organizing the Symposium event.

Front Row (from left to right): Sophia Hager, Caterina "ShinShin" Erdas, Moufidatou Adedoyin, Sydney Junker, Rebecca Brody, Sherry Boassard

Back Row (from left to right): Ezra Szanton, Mercedes Thompson, Nick Good, Azeem Lyons, Robert Blanchard, Robert Henry, Alida Schott, Elijah Dukes, Claire Wayner

Not Pictured: Iven Chen-Van Dyke, Duncan Parke, Mikell Myers

Developing a Reporter System for Exosome Fusion

Moufidatou Adedoyin

Mentor: Dr. Charles Bailey
Institution: Johns Hopkins School of Medicine

The purpose of my research is to develop a sensitive reporter system for detecting the fusion of exosomes to their target cells. The methods that I am using to conduct my research include PCR, ligation, transformation, DNA preparation and purification from bacteria, maintaining adherent epithelial cells in culture, protein sample preparation, quantitation, immunoprecipitation, exosome purification, fluorescence microscopy and Western blot. Western blot and fluorescence microscopy are my methods of data analysis. I am using Western blot to detect the expression of proteins in isolated exosomes and fluorescence microscopy to analyze the intracellular location of green fluorescent protein (GFP). I anticipate that cells transfected with the reporter system will produce exosomes that express the reporter and deliver it to neighboring cells.

Effects of Geometrical Constraints on the Mechanical Properties of Engineered Micro-tissues

Robert Blanchard

Mentor: Dr. Dan Reich
Institution: Department of Physics, Johns Hopkins University

Cells and tissues constantly exert force. Seeding cell laden collagen solution into polydimethylsiloxane (PDMS) devices can result in tissues with measurable force. However, these devices have not been optimized to grow tissue in such a way that is easy to measure. To optimize these devices, short and long tissues were contrasted to determine the most efficient type of tissue. Tissues formed from cell lead self-assembly of a collagen matrix inside the microwell arrays on a PDMS substrate, with each microwell containing two flexible pillars. A measurement is then recorded of the deflection of the flexible pillars, after tissue development, allowed for the quantification of the force exerted by the two types of tissue. In addition, I evaluated the ability of the tissues to remain viable for the study of their pillar. I showed that short tissues exerted more force than long tissues, which is preferable, but long tissues tended to remain viable longer than short tissues. However, the small size of the patterns required to produce short tissues easily allow for enough of them to be produced, so as to negate that. Together, these two results show that short tissues are more efficient than long tissues for Bio-MEMS that test mechanical force.

Junior Research Abstracts

Using Oyster Filtration to Remove Coral Pathogens from the Marine Environment

Sherry Bossard

Mentor: Dr. Colleen Burge
Institution: Institute of Marine and Environmental Technology

The purpose of my research is to isolate a coral pathogen, *Serratia marcescens*, from live coral samples to be used in an experiment that will determine whether oysters can remove the coral pathogen from the marine environment. To do this, I grow all of the bacteria from the coral samples on different media, eliminating bacterial isolates that exhibit positive growth on a media specific to a certain type of bacteria that is not *S. marcescens*. Then, after the amount of isolates in consideration is smaller, I perform *Serratia* specific PCR to identify which isolates are the desired coral pathogen. I analyze the data from the gels used during the gel electrophoresis of the amplified bacterial DNA. I expect that not many of the isolates will be *S. marcescens* but that there will be a small portion of the isolates which are identified as the desired pathogen.

The Effect of Hypoxia on Stem Cell-Derived Endothelial Cells

Rebecca Brody

Mentor: Dr. Sharon Gerecht
Institution: Department of Chemical and Biomolecular Engineering, Johns Hopkins University

Induced pluripotent stem cell-derived endothelial cells (iPSC-derived ECs) represent a promising avenue to repair and replace blood vessels damaged by injury or disease. This cell type could be used to create patient specific vascular grafts in the lab, which could then be used for clinical treatments. However, little is known about how iPSC-derived ECs function in comparison to physiologic endothelial cells. This includes the response of iPSC-derived ECs to hypoxic conditions, which are known to stimulate changes to the vasculature *in vivo*. We investigated these unknowns using an *in vitro* model system. This system uses a synthetic, three-dimensional environment, which employs the collagen I protein to mimic the physiological conditions in which blood vessels can form. It was found that iPSC-derived ECs do in fact behave differently than physiologic endothelial cells, depending on the oxygen concentration of their environment. In low oxygen environments, the iPSC-derived ECs consumed less oxygen than the physiologic stem cells. In addition, the networks formed by iPSC-derived ECs in low oxygen environments were longer and thicker. These results suggest a fundamental difference between iPSC-derived ECs and physiologic ECs, but shows that iPSC-derived ECs can still form effective vascular networks in low oxygen conditions.

Determining the Perceptual Qualities of External Transcutaneous Stimulation Using ERMs, LRAs, and Electrical Stimulation of the Median Nerve

Iven Chen-Van Dyk

Mentor: Dr. Nitish Thakor
Institute: Department of Biomedical Engineering, Johns Hopkins University

The sense of touch is often taken for granted, but it is essential to understanding and controlling one's interactions with the environment. It is therefore essential that in the development of prosthetic limbs, this system be taken into account. To simulate this, prostheses use sensors to gather information about contact and transform that into a stimulus pattern that the user can feel. The stimulus itself can be achieved in several ways. These ways can be characterized into internal and external stimuli, with internal meaning that it requires implantation. External stimuli are comparatively cheaper, these kinds of stimuli can be separated into mechanical and electrical stimuli. These stimuli can take the form of vibrating motors, low power electric shocks, or similar devices. I want to determine whether mechanical or electrical stimuli are the most effective forms of stimulus for simulating the sense of touch in prosthetic limbs. To do this I have laid out a two step project. The first step focuses on evaluating and understanding the materials and devices that I am working with and the second step combines sensors and stimuli to produce a fully functional tactile feedback system that will be mounted to an actual prosthetic limb and tested in realistic setting with each stimulus form. The first step has been separated into two sets of experiments. The first set evaluates the sensors and the second set evaluates the stimuli so that the system can be properly calibrated to form the tactile feedback system. This project will provide information that will be essential to future tactile feedback system designs allowing us to choose the most effective stimulus for the apparatus.

Comparison of the *in vivo* Killing Activity of the Antimalarial Quinolines Pyronaridine and Tafenoquine

Elijah Dukes

Mentor: Dr. David Sullivan
Institute: Department of Molecular Microbiology and Immunology, Johns Hopkins School of Public Health

With the increased resistance of *Plasmodium* parasites to certain antimalarials, drugs must be characterized in new ways. Killing properties of drugs, such as tafenoquine and pyronaridine, are underreported. Here we describe the killing activity of the two 8-aminoquinolines using transgenic *P. berghei* expressing luciferase in an *in vivo* killing assay. A novel blood transfer method, with samples measured in photons/second from luciferase and compared to blood films, is employed to get a fair comparison of the killing activity of the two drugs. Pyronaridine is shown to have the highest killing capabilities at 40 mg/kg after 24 hours of influence in the mouse. After seven hours, however, tafenoquine and pyronaridine seem to have about the same amount of activity. We come to the conclusion that pyronaridine is a more potent killer than tafenoquine.

Junior Research Abstracts

PCR Diagnostic for Chagas Disease Using Urine Samples

Caterina Erdas

Mentor: Dr. Alan Scott
Institute: Department of Molecular Microbiology and Immunology, Johns Hopkins School of Public Health

Chagas disease, caused by the parasitic protozoan *Trypanosoma cruzi*, is prevalent in Latin and South America. Chronic infections can lead to heart and gastrointestinal problems, but because the body does not make many antibodies at that point, serological diagnostics are not specific. PCR assays from blood samples have proven to be more specific than serological methods. In addition, the kidney concentrates the waste from the blood, so urine may have a higher concentration of *T. cruzi* DNA. In addition, DNA is not efficiently filtered through from urine samples, which is an ineffective method of DNA collection. This study will test the sensitivity and specificity of a PCR diagnostic from urine sample in 3 phases: picking a *T. cruzi* primer and ensuring it successfully amplifies DNA, testing the effectiveness of the proposed collection method, and doing a large scale study with real urine samples. As of now, Phase 1 has been completed. A primer which amplifies a *T. cruzi* specific satellite DNA repeat (188bp) was chosen. Six PCRs were carried out, and after changing the thermocycler procedure, the last 3 were successful. The next steps are to carry out Phase 2 and 3. This diagnostic could potentially help individuals with chronic infections get the help needed, and the proposed DNA collection method could be used in studies to improve urine sample related data collection.

Developing Alpha-Actinin 1 for an Anti-Cancer Small Molecule Screening Platform

Nicholas Good

Mentor: Dr. Douglas Robinson
Institute: Robinson Lab, Johns Hopkins School of Public Health

Cancer cells utilize pseudopodia to metastasize and form secondary tumor sites. These pseudopodia are composed from the actin cytoskeleton, and held together by an array of crosslinking proteins which hold the individual actin filaments together. Two of these crosslinking proteins, α-actinin-1 (ACTN1) and α-actinin-4 (ACTN4), are of particular interest because only ACTN4 localizes in the protrusions and helps with cell motility, despite the homologous nature of these two proteins. I have worked to clone and purify the ACTN1 protein to analyze its actin binding affinity. This was done by PCR amplifying the ACTN1 gene, ligating into a pBiEx vector, and transforming the plasmid into specialized strains of *E. coli* designed for protein replication. The DNA from these transformations was purified and tested via gel electrophoresis to ensure the accuracy of the resulting DNA. The plasmids were then transformed into a second set of bacteria and a maxiprep of the resulting DNA was performed to ensure that there was an abundance of the ACTN1 protein on which to do the analysis.

Classifying Responses to Repellents in the Malaria Mosquito, *Anopheles gambiae*

Sophia Hager

Mentor: Dr. Christopher Potter
Institution: Department of Neuroscience, Johns Hopkins School of Medicine

Research into the olfactory system of the malaria mosquito has potential applications in developing more effective repellents. *Anopheles gambiae* were bred with GCaMP, a molecule that glows more brightly in the presence of calcium, and subjected to the odors of repellents. This visually showed the responses of the neurons in the first segment of the antenna to the odors chosen. The responses were recorded in the first segment of the right antennae, and the activity was graphed. The analysis of the recordings of the responses showed that there seemed to be at least two subgroups of repellents, as some provoked a visual response in one or more neurons, and others did not show any visual response. Of the latter group, both restricted the response to 1-octen-3-ol, an attractant when paired with carbon dioxide.

Material Science- Active Nematics

Robert Henry

Mentor: Dr. Robert Leheny
Institution: Department of Physics, Johns Hopkins University

Through research in the field of material science, we have knowledge of the structures and properties of many different materials. Materials have different classifications depending on their properties. These different classifications are, biomaterials, nanomaterials, ceramics, metals, plastics (polymers), and electrical, optical, and magnetic materials. A new category of materials that scientists are still trying to learn about amorphous metals. Recently it was discovered that an amorphous metal can contain a magnetic field, which was previously unknown. They are also looking into making artificial diamonds and metallic foam that have practical applications. As we better understand how materials work, we will have better means of getting into space, cars will become more efficient and release less gases, and injuries will be healed more easily.

Human Risk-Based Decision-Making in Choice and Non-Choice Trials

Sydney Junker

Mentor: Dr. Veit Stuphorn
Institution: Department of Cognitive Science, Johns Hopkins University

Humans, much like many mammals, come across decisions every day; these decisions can include options that are not guaranteed to take place every time, which are known as risks. These are generally impacted by the neural mechanisms that take place. Humans are expected to avoid risks when they are about to gain something, although they are expected to take more risks when they are about to lose something. To test this in the future, I have coded a template in MATLAB that will be used for the upcoming experiment. This template matches that of a prior experiment that studied risk-based decision-making in Japanese macaque monkeys, and positive results are expected similar to that experiment.

Junior Research Abstracts

Blood Concentration in *Biomphalaria Glabrata* Snails

Azeem Lyons

Mentor: Dr. Clive Shiff
Institute: Shiff Lab, Johns Hopkins School of Public Health Department of Molecular Microbiology and Immunology

Schistosomes are one of the most widespread human-infecting parasites, and they utilize *B. glabrata* snails as intermediate hosts, granting the *B. glabrata* snails significance in the realm of vector control for schistosomes. This project sought to use blood cell concentration as a metric for healthy conditions in *B. glabrata* snails and determine a baseline for this metric to be used in further investigations. To this effect, samples of blood taken from *B. glabrata* snails were analyzed to determine the concentration of blood cells within. The results found indicate that a healthy concentration of blood cells does in fact correlate to the size of the organism, with larger snails having a higher concentration of cells in blood. This metric will be used as a baseline to indicate snail health in further investigations.

Exploring the Effects of Step Cadence on Energy Expenditure During Walking

Mikell Myers

Mentor: Dr. Amy Bastian
Institute: Kennedy Krieger Institute

In the world of physical therapy, there lies a void in the knowledge that we have regarding the relationships that exist between step frequency (cadence) and energy expenditure during walking for humans after having a stroke. Knowledge of this relationship already exists in reference to healthy humans. This project acts as the first stage of a larger project which will identify the relationship in subjects after stroke—this project seeks to test a paradigm in which the participants, all of which are healthy, are made to walk at differing percentages (+/- 10-20%) of their self-selected cadences at a fixed speed. For the purpose, a metronome was used to pace the subjects on the treadmill. Success of the paradigm is measured by the ability of the paradigm to reproduce the pre-existing relationship between healthy human step cadence and energy expenditure. Results show that as the healthy subjects reach their self-selected cadence, their expenditure is the lowest; walking at an increasing deviation, in either direction, from the self-selected cadence results in a greater expenditure—this results in the same pre-established parabolic relationship. The project confirms that the paradigm does successfully reproduce the pre-existing relationship between cadence and energy expenditure in healthy humans during walking.

Development and Implementation of a Portable ECG Amplifier

Duncan Parke

Mentor: Dr. Ralph Etienne-Cummings
Institution: Department of Electrical Engineering, Johns Hopkins University

As the world becomes increasingly mobile, and technology continues to develop, it makes sense to automate some strictly procedural processes in order to increase overall societal efficiency. The Electrocardiogram (ECG) is a standard medical test which can be administered to check for heart abnormalities without incision. The process of collection and analysis of ECG can be time consuming for doctors. As such, this paper describes the development of an accurate, low power, 3-lead, 5cm x 4cm ECG Amplifier, prepared for FPGA integration to collect ECG data away from medical settings, in order to decentralize preliminary testing, and in turn increase doctor time efficiency by providing accurate information before a patient needs to come into a medical setting.

Deciphering the Sedimentary Record of Galle Crater, Mars

Alida Schott

Mentor: Dr. Kevin Lewis
Institution: Department of Earth and Planetary Sciences, JHU

The formation of central crater mounds on Mars is not well understood, especially in the understudied mid-latitude regions. Changes in Mars' climate have affected the amount of sediment and water present in a region, which has determined the characteristics of the sedimentary rocks that have formed. Galle crater, located at -51˚ latitude, has long been assumed to be a glacial deposit based on the apparent thinning trend of the layers. A High Resolution Imaging Science Experiment (HiRISE) image and associated digital elevation model (DEM) were used to calculate the orientations and thicknesses of the sedimentary beds in Galle crater. By measuring bed thicknesses, taking into account the three-dimensional layer orientations, we find that, contrary to appearances, the layers in Galle crater are not thinning. Instead, we find an abrupt transition from ~5 to 40 m thick layers at the top of the mound to sub-1 to 4 m thick layers. Our results suggest that Galle crater may not be a glacial deposit, composed mostly of ice, and that the layers record a dramatic climate shift in Mars' history.

Junior Research Abstracts

Design of a Solar Module for Hex DMR

Ezra Szanton

Mentor: Dr. Greg Chirikjian
Institution: Department of Mechanical Engineering, Johns Hopkins University

The Hexagonal Distributed Modular Robot (Hex DMR) consists of a team of homogeneous agents, Hexes, which are each made up of homogeneous modules which contribute to their function. Hex DMR was created as a proof of the concept for self-repair in modular robots. Repair is accomplished by using an actuator module, which each Hex has, to extract the malfunctioning module from the malfunctioning Hex and install a new module which is obtained either from an extra slot on another Hex or a bank of modules. The most common fault state is currently that of the battery module running out of power. Creating a new type of power module with a way to capture energy from its surroundings is a long term solution which would not only extend the battery life, but has the potential to allow the modules to remain autonomous indefinitely. I addressed this goal using solar power by integrating solar panels into the circuit that powers the battery in the power module. Ultimately, this design is a proof of concept for any form of renewable energy source that could be integrated into a modular robot system and is another useful step towards robotic autonomous repair.

Methodology of Antibody in Clearance of Virus from CNS

Mercedes Thompson

Mentor: Dr. Diane Griffin
Institution: Department of Molecular Microbiology and Immunology, Johns Hopkins School of Public Health

Sindbis virus is an alphavirus that can cause encephalomyelitis (the inflammation of the brain and spinal cord). Alphaviruses, in general, infect neurons of the central nervous system, which encompasses the brain and spinal cord, and causes acute encephalomyelitis in many mammals. This is of particular interest in the study of the immune response to viral infection of neurons, and understanding the immune response would allow for effective methods to treat the disease. Viral infection of neurons is of great interest due to the fact mature neurons cannot replicate and therefore cannot be killed like other cell types by the immune system to clear virus from the body. A correlation between antibody treatment and clearance of virus from the cell has been made in prior studies. Viruses have been established to change the cytoskeleton of the cells they infect for replication, and it is hypothesized that antibody may counteract these cytoskeletal changes in order to clear the virus from the cell. In this study, cytoskeletal proteins such as actin and b-tubulin will be stained in mock infected, virus infected, and virus infected and treated with antibody neurons.

Engineering *E. coli* Removal from Stormwater

Claire Wayner

Mentor: Dr. Sarah Preheim
Institute: Department of Environmental Health & Engineering, JHU

Stormwater runoff often becomes contaminated with biological pathogens, such as *Escherichia coli*, that can have negative impacts on urban aquatic ecosystems and the health of human communities associated with those water systems. In order to mitigate stormwater pollution, engineered infiltration systems (EIS) have become a popular solution. Much research has been done on the impact of EIS on filtering out chemical pollutants, but little is known about its effectiveness when it comes to biological pathogens. In particular, the relationships between bacterial biofilm slimes naturally found on EIS in the environment and these pathogens remain unexplored. My research aims to characterize the relationships between biofilms of naturally occurring stormwater bacteria and *E. coli*, a pathogen indicator, on EIS. By exploring these relationships further, I can help draw conclusions as to how effective EIS is at removing pathogen pollutants and how its design could be improved to reduce stormwater contamination and improve urban water quality.

Sophomore Interest Statements

The sophomores have completed the initial phase of the Ingenuity Research Program. During the first semester, they identified topics of interest, researched current information about their selected topics, and sought mentors from the local scientific research community. Those continuing with Research Practicum will begin work at their lab placements this summer. The posters the sophomores present at Symposium represent a first effort to present their research topics to a public audience.

Front Row (left to right): Lily DeBell, Sumaita Ahmed, Tori Legaspi, Ruth Martin

Middle Row (left to right): Karen Griffin, Michelle Moyaka, Elizabeth Zheleznyakova, Rachel Pontious, Evains Francois

Back Row (left to right): John Halpin, Chiad Onyeje, Rohan Kane, Nathanial Alper, Keara Caverly, Abby McKenna, Omobolade Odedoyin, Taylor Young

Sophomore Interest Statements

The Epigentic Phenomena

Sumaita Ahmed

Epigenetics is a subset of genetics. It is the study of changes to the epigenome that are triggered by modifications to gene expression. These changes are caused by various environmental factors instead of an alteration of the genetic code. The two main forms of epigenetic regulation are DNA methylation and histone modification. It is possible for offspring to inherit the altered form of the epigenetic tag. The discovery of epigenetic inheritance contradicts the popular held belief that the only means of transferring genetic information is through DNA. Numerous diseases ensue from epigenetics related causes. Among them are diabetes, cardiovascular disease, obesity and cancer. I will continue my research in the lab of Dr. Yumi Kim. She studies the function of meiotic processes in the development of aneuploidy, a topic which falls under my broad interest of genetics. Under the guidance of Dr. Kim, I hope to learn more about heredity and its role in the development of diseases and disorders.

Aquaculture and Marine Conservation

Nathaniel Alper

When it comes to the protection of marine organisms and marine resources, there are multiple technologies that can contribute directly to the protection of species and further research. I've narrowed my interest to one specific area of research: aquaculture, or fish farming. This is a potential food source, but also a way of taking pressure off of wild stocks of fish caused by overfishing. The first method of aquaculture uses large nets that float in the ocean to corral fish, while the other method uses tanks on land. The latter tends to have more potential for sustainability; however, it is more expensive. In my efforts to learn more about the topic, I have identified Dr. Eric Schott, a researcher at the Institute of Marine and Environmental Technologies, as my future mentor. His lab focuses on the effects of infections in marine animals in aquaculture. We will be using the mutation of the CsRV1 Virus to track the migration behavior of the Blue Crab, as well as investigate how to stop the infection of soft shell crabs in aquaculture.

Use of Molecular Techniques for Genetics Research

Keara Caverly

Molecular techniques are methods used by scientists to perform specific experiments and manipulate molecular materials, such as DNA. These techniques can be used in the fields of molecular biology, genetics, and biochemistry. Past molecular techniques used include PCR, which duplicates DNA, and DNA sequencing. A more recently developed method in molecular techniques is mutagenesis, which is when researchers use different methods to create a mutation in a genetic sequence. I did not find this technique at any labs near here, so I decided to change my focus to genetics. I found a lab placement under Dr. Johnston, who specializes in stochastic cell expression in the photoreceptors in the eye.

Sophomore Interest Statements

Type I CRISPR Systems

Lily DeBell

CRISPR/Cas9 is a revolutionary genome editing technique, centering on the use of bacterial DNA sequences, which produce the Cas9 protein. Cas9 has the unique ability to snip out DNA sequences from foreign genomes, thus preventing their expression. In Type I CRISPR systems, this property is part of the bacterial immune response. Studying these systems has enabled the development of new drugs to prevent antibiotic resistance. Additionally, Type I systems are an area of study for the development of precision treatment of genetic diseases through genome editing. CRISPR will continue to be a powerful tool, especially in public health and medicine, where my primary interests lie. To further explore this topic, I plan to conduct research in the lab of Dr. Scott Bailey, a Johns Hopkins Bloomberg School of Public Health researcher, who develops imaging techniques for the proteins of Type I systems.

Biomimicry in Robot Locomotion

Evains Francois

Biomimicry is creating something that takes inspiration from nature. An example of this is the creation of Velcro, which is modeled after a burr (the small, spikey balls that get stuck to clothes when you are hiking). Biomimicry is used all the time in modern society. One thing that scientists are using biomimicry for today is to create small autonomous robots that can navigate through rough terrain. Scientists in this field are studying small animals, such as geckos and insects, in order to create such a robot. A robot like this would be very helpful in disaster zones to search for people in places that a human would have trouble getting to, such as an area affected by an earthquake. I am excited that Dr. Chen Li from the Department of Mechanical Engineering at Johns Hopkins University has agreed to be my mentor next year for research practicum. In Dr. Li's lab I will be studying the locomotion of cockroaches to learn how they navigate through obstacles.

Epigenetic Regulation in Stem Cell Fate

Karen Griffin

Epigenetics and stem cells are the two main topics I plan to research. Epigenetics is the process of altering gene activity or inherited phenotype without changing the DNA sequence. Stem cells are cells that can give rise to different types of cells with different functions. I have always been fascinated with genetic processes and stem cells, and learning about epigenetics narrowed my interest. I want to focus on researching epigenetic regulation in stem cell fate. Understanding this relationship could lead to technologies or methods that involve stem cell therapy or treat genetic diseases, such as cancer, and provide a better understanding of stem cell fate and function. To research this specific topic I have found a mentor, Dr. Alex Bortvin, at the Carnegie Institute of Science. In Dr. Bortvin's lab I will study epigenetic changes on oocytes using a mouse model.

Zebrafish as Model Organisms to Study Metabolic Disease

John Halpin

My topic of interest is embryology and lipid metabolism, specifically zebrafish embryology and how these fish can be used as model organisms to study metabolic diseases and how lipids are metabolized. The research of lipid metabolism gained popularity in the 1950s when molecular biochemistry started to explode in scientific popularity, largely due to technological advances. The field has been vigorously studied ever since, but there are still mysteries there that have eluded scientists for a long time. On the other hand, zebrafish research began in the 1960s, but only became scientifically popular in the 1990s, due to some high profile articles explaining their uses as model organisms. Currently, the most prominent research with zebrafish is using them to model metabolic diseases, such as type 2 diabetes and atherosclerosis, to better understand how they function, as they are becoming increasingly dangerous due to our high cholesterol diets. Zebrafish are genetically similar to humans, so they are applicable organisms to study other diseases as well, such as Alzheimer's and dementia. In addition, the zebrafish genome was fully mapped a few years ago in 2013, which has led to exciting genetic developments, including new methods of studying gene mutations. Zebrafish are becoming increasingly popular every year, and have proven themselves to be model organisms, so this field is going nowhere but up in the future, especially considering our relatively newfound desperation for knowledge on metabolic diseases. To further explore this topic, I plan to conduct research in the lab of Dr. Steve Farber from the Carnegie Institute for Science. Dr. Farber is also a board member for the Ingenuity Project. I am looking forward to learning from him.

Microbial Biotechnology

Tori Legaspi

When people hear the word "microbes" they think of harmful bacteria or deadly viruses, but microbes actually play a vital role in our everyday lives. Microbial biotechnology is the technological application of microbiological systems or microbial organisms to create or improve products or processes. The most interesting product of microbial biotechnology is algal biofuel, an energy source created from the oil in microalgae. Microbial Biotechnology, specifically its application to create algal biofuels will become increasingly important as we transition from relying on fossil fuels to alternative green sources of energy.I have a dual interest in microbial biotechnology and nanoscale structures, and in the end, I decided to look for a mentor in the field of nanoscale structures and was fortunate to find Dr. Frechette. I will be studying how the nanoscale structures of adhesion products relate to the performance of these products under different circumstances.

Culturalization of Limbal Stem Cells Into Corneal Transplants

Ruth Martin

Stem cells are cells that can differentiate into more specialized cell types. Ophthalmology, the branch dealing with the anatomy, physiology, and diseases of the eye, is used to discover new techniques that can be useful in curing ocular diseases. Corneal diseases usually consist of cataracts, corneal blindness, or corneal scarring. The most efficient way of curing corneal blindness, is by conducting a corneal transplant using limbal stem cells. Limbal stem cells are located near the edge of the cornea and are responsible for repairing damaged corneal cells in the eye; however, if the cornea experiences too much damage, then the limbal cells will be permanently damaged, and the only way to repair the eye is by getting a transplant. While researching more into this topic, I have identified Dr. Esen K. Akpek as my first potential mentor candidate. Dr. Akpek is a Professor of Ophthalmology at the Johns Hopkins University of Medicine, and is currently a part of the surgical faculty of the Wilmer Eye Institute at JHU. Dr. Akpek specializes in corneal transplants, cataracts, and the cornea/anterior segment disease. Hopefully, she will be able to guide me through my research project.

Sophomore Interest Statements

Alzheimer's Research: A Fight to Remember

Abby McKenna

Alzheimer's disease is a worldwide problem affecting millions of people. The disease is characterized by the collection of plaques and neurofibrillary tangles that prevents synapses from transmitting signals between neurons in the brain. This leads to cognitive decline, and eventually death. I would like to focus my research on the plaques, which are formed from the protein beta-amyloid. My possible mentor candidate is Dr. Alena Savonenko at the Alzheimer's Disease Research Center at Johns Hopkins. Currently, she is researching the role of beta-amyloids in the formation and progression of Alzheimer's disease through the use of mouse models. I find the specifics of her work especially interesting, and something that I would like to pursue research in.

Sexually Transmitted Diseases

Michelle Mokaya

Sexually transmitted diseases, also known venereal diseases, are diseases which are transmitted through direct contact of the genitals, rectum, or mouth. There are over 19 million new cases of sexually transmitted diseases (STDs) , and adolescents, people from the ages of 15 to 24, make up half of those cases. This statistic was very stunning to me and sparked my interest in STDs. For the past few months, I have been researching information on STDs, such as the different types of diseases, different treatments and prevention programs, and the demographics of STDs. This research is important because it gives us access to comprehensive data which can later be used to create more effective STD prevention and intervention programs. Even though I had the intentions of researching STDs, I found a mentor doing research in an equally interesting topic. Like STDs, parasitic infections is also an important public health issue, especially in third world countries. I will be working with Dr. Alan Scott who studies the immunology of parasitic nematodes. Detecting the presence of these parasites is very difficult because the infections created by the parasites are asymptomatic. I will be helping Dr. Scott and his team create improved methods to accurately and efficiently detect parasitic nematodes.

Stem Cell Therapy Application in Neurodegenerative Diseases

Omobolade Odedoyin

Neurodegenerative diseases (NDDs) are a wide range of short term and long term conditions in which neurons and neural cells in the brain and spinal cord are lost. In many of these conditions, different types of neurons and neural cells die within a restricted brain area, causing degeneration of many types of neurons. As the abundant presence of NDDs has grown throughout the world's population, so has the need for stem cell application in this area of research to potentially break this barrier. Stem cells are regenerative cells that repair themselves; their special properties are being applied to NDDs to potential create a solution to their destructive. I have identified Dr. Amanda Lauer, PhD, in the Department of Otolaryngology at The Johns Hopkins University School of Medicine, as my mentor. My future research in her lab will focus on understanding the relationship between auditory input and Alzheimer's disease.

Sophomore Interest Statements

Visual Recognition and Processing

Chiad Onyeje

My research goal is an understanding of the world around us. My research thus boils down to the brain processing information and storing it for later use. I chose this line of research because of my already established interest in memory; however, I wanted to also try something new as well. While getting an idea for various studies in neuroscience, my research lead me to my current mentor candidate, Kristina Nielsen, a professor of neuroscience at Johns Hopkins University. Her research focuses on discovering more about the complex process of visual recognition. I have been accepted to work in her lab starting in the summer, and I am interested to get a deeper understanding of the research she conducts.

Biological Solutions for Water Quality

Rachel Pontious

My research topic is biological solutions for water quality. Poor water quality is a global issue. One of its chief causes is stormwater runoff, which is the water from precipitation that picks up pollutants and washes into water bodies. These pollutants can have very detrimental effects on water ecosystems. However, certain living organisms can lessen this pollution. Wetlands can absorb stormwater before it reaches a water body and filter it of pollution. Oysters consume particles in water bodies, ridding them of much harmful algae and suspended sediment. Denitrifying bacteria convert organic nitrogen, which pollutes water, to inorganic nitrogen gas. Dr. Sarah Preheim, an assistant professor at the Department of Environmental Health and Engineering will mentor me for my Ingenuity Research Practicum. She mainly studies bacteria, their genetics, and water quality. One project she and her graduate students are working on is the effect of *E. coli* growth on the performance of stormwater filtration devices. Another one of her projects is the variety and ecosystem roles of bacteria in aquatic dead zones.

Neuropsychiatric Diseases & Disorders

Taylor Young

The field of neuroscience allows scientists understand the brain and its complexity. In this field, scientists study the nervous system and the brain in order to create a better understanding of how humans act and function. I would like to pursue my research in neuropsychiatric diseases and disorders and more specifically, their treatment and detection. A potential mentor I have identified is Dr. Solange Brown, of the Solomon H. Snyder Department of Neuroscience at Johns Hopkins University. Dr. Brown does research on how neural circuits in the brain are functionally organized and how circuit irregularities cause neurodegenerative and neuropsychiatric diseases. Dr. Brown wants to know the effect of these irregularities on cortical processing and their association with the neuropsychiatric disorders autism and schizophrenia. Research in neuropsychiatric diseases and disorders is extremely important because it can lead to highly effective treatments and possible cures.

Sophomore Interest Statements

Nanotechnology

Elizabeth Zheleznyakova

Nanotechnology is technology on a scale from one to one hundred nanometers. The field also involves the study of the properties of materials at that scale. Nanotechnology is greatly aiding progress in many fields, such as electronics, medicine, and engineering, because it allows for more precise studies, as well as for the miniaturization of other technologies. Additionally, nanotechnology can be applied more directly to daily life - in consumer products, manufacturing, and renewable energy sources. Much of the current research in nanotechnology involves building increasingly complex nanosystems of interacting parts, which can be used for various purposes. For my research, I will be working with Dr. Michael Pacella and Professor Rebecca Schulman's DNA Nanotechnology and Intelligent Materials group at Johns Hopkins University. DNA nanotechnology involves incorporating DNA into a variety of nanostructures that take advantage of some of its properties, such as self-assembly.

Cosmology: A Universal Truth

Rohan Kane

My topic is cosmology. The theory behind the field started out as religious explanations for ancient civilizations' existence, but developed into a much more scientific area of study. Much of the basis for today's cosmology work derives from work done in the twentieth century, such as progressing our understanding of redshift, the cosmological constant, cosmic microwave background radiation, and more. This all leads up to our effort to understand where our universe comes from. This century has been a compilation of evidence in support of the Big Bang being the confirmed explanation of how our universe originated. Inflation is a key component to the theory, and suggests that for a short time after the Big Band, the universe rapidly accelerated, and then slowed back down. The period of inflation produced many ripples through spacetime, leaving imprints on the CMB, and supposedly produced gravitational waves. These effects were found as a result of many recent experiments and missions, proving inflation. In the near future, I'll be involved in the field, as I'm taking a position being mentored by Dr. Jennifer Lotz in the subcategory of galaxy formation and evolution.

Class of 2017: College Acceptances

* denotes the college /university the senior will be attending

Amelia Armstrong
Hofstra University
University of Maryland, Baltimore County
Purdue University*
Stevens Institute of Technology

Benjamin Baitman
Davidson College
Northwestern University
University of Maryland, College Park (Honors College)*
University of Pittsburgh (Honors program)

Olivia Birkel
Boston University
University of Maryland, College Park (Honors College))
Washington University in St. Louis*
University of Pittsburgh (Honors College)
SUNY Stony Brook (Honors College)

Sigurdur "Ben" Bjarnson
Boston College*
Boston University
University of Maryland, Baltimore County
University of Maryland, College Park (Honors College)

Keturah Boone
Albright College
Hofstra University*

Sarah Bowden
Indiana University of Pennsylvania
Johns Hopkins University
Oberlin College
Trinity College
Washington College*

Sophie Cargnel
University of Colorado at Boulder
University of Maryland, Baltimore County
University of Maryland, College Park*
Pennsylvania State University
University of Pittsburgh
Towson University

Caitlin Cole
University of Maryland, Baltimore County
University of Maryland, College Park (Honors College)*

Emma Eklund
Goucher College
University of Maryland, Baltimore County
University of Maryland, College Park (Honors College)*
University of Pittsburgh
Towson University

Branden Harris Etienne
Capitol College of Technology
Georgia Institute of Technology
University of Maryland, Baltimore County
University of Maryland, College Park* (Scholars Program)
Stevens Institute of Technology

Nick Eusman
Bucknell University
Lafayette College
University of Rochester
Virginia Tech
Worcester Polytechnic Institute*

Lauren Fink
Johns Hopkins University*
University of Maryland, Baltimore County
Tulane University

Class of 2017: College Acceptances

Andrew Frock
Capitol College (Capitol Scholars)
Johns Hopkins University
University of Maryland, College Park (Honors College, Banneker-Key Scholar)*

Sidney Garcia
Coastal Carolina
Towson University
Pennsylvania State University*
University of Minnesota

Stephen Grabowski
Johns Hopkins University
University of Maryland, College Park (Honors College)
Purdue University*
The Ohio State University
Virginia Tech

Robin Graham-Hayes
University of Maryland, Baltimore County
University of Maryland, College Park (Scholars Program)
Johns Hopkins University (Hackerman Scholarship)
Franklin Olin College of Engineering*

Anisa Hofert
Emory University*
University of Maryland, Baltimore County
University of Maryland, College Park (Honors Program)
University of Wisconsin, Madison

Sean Holley
University of Baltimore*
Morgan State University
Goucher College
Towson University

Michelle Holmes
Coastal Carolina
Morgan State University
Pennsylvania State University*
Towson University
University of Maryland, College Park

Kira Hunt
University of Maryland, Baltimore County
Roanoke College*
St. Mary's College of Maryland

Jermaine Jackson
Morgan State University*
University of Maryland, Baltimore County
Michigan State University

Yoav Kargon
Duke University*
Johns Hopkins University
Reed College
Rice University
University of Maryland, College Park (Honors College, Banneker-Key Scholar)

Joshua Lang
Capitol Technology University
George Mason
Stevenson University*
University of Maryland, Baltimore County

Juelle Lee
Fort Valley State University*
Highpoint University
Howard University
University of Maryland, Baltimore County
University of Maryland, College Park

Jasmine Long
University of Maryland, Eastern Shore
Salisbury University
St. Mary's College of Maryland*
York College of Pennsylvania

Julianna Lucas
Eckerd College*
University of North Carolina at Wilmington
St. Mary's College of Maryland
Unity College

Michael Marinelli
University of Baltimore
Drexel University
George Mason University
Howard University
Loyola University
University of Maryland, College Park (Scholars Program)*
Temple University
Towson University

George Mastoras
University of Colorado, Boulder
University of Maryland, College Park (Honors College)*
Ohio State University
University of Illinois
West Virginia University

Marlena Milic
Loyola University Maryland
University of Maryland, Baltimore County*
Morgan State University

Eric Noffsinger
University of Colorado at Boulder
University of Maryland, College Park*
Pennsylvania State University
Virginia Tech

Mordecai Obeng-Appiah
Bucknell University
University of Maryland, Baltimore County
The University of Maryland, College Park (Honors College)
Morgan State University*
Ohio University
Pennsylvania State University
Temple University
York College of Pennsylvania

Martin Orellana-Guzman
University of Maryland, Baltimore County (Meyerhoff Scholar)*
University of Maryland, College Park (Scholars Program and IAP)
Northeastern University
Rutgers University – Camden
Temple University

Sydney Rosebrough
Drexel University
Hampton University
Rutgers University – New Brunswick
Syracuse University
Temple University*
The Ohio State University
Towson University

Alexander Shafer
University of Colorado at Boulder
University of Illinois at Urabana-Champaign
University of Maryland, College Park*
Pennsylvania State University
University of Pittsburgh
Purdue University

Aishwarya Shettigar
Carnegie Mellon University
Johns Hopkins University
University of Maryland, Baltimore County
University of Maryland, College Park (Honors College, Banneker-Key Scholar)*
Williams College

Class of 2017: College Acceptances

Jacob Smith
Brandeis University*
University of Maryland, Baltimore County

Samuel Smith
Brandeis University*
University of Maryland, Baltimore County
University of Maryland, College Park

Jason Sofolahan
Howard University
University of Maryland, College Park
Morgan State University*
North Carolina A&T State University

Olivia Vestal
Loyola University of Maryland
University of Maryland, Baltimore County
Morgan State University
Notre Dame of Maryland University
St. Mary's College of Maryland
Stevenson University*

Monika Watat
Howard University
Johns Hopkins University*
University of Maryland, College Park
(Honors College)
Morgan State University
Temple University
Towson University
Washington University in St. Louis

Craig Williams
DigiPen Institute of Technology*
Maryland Institute College of Art
Rochester Institute of Technology
Savannah College of Art and Design
University of California, Santa Cruz

Sydney Worsham
Boston University
Johns Hopkins University*
Oberlin College
Occidental University
University of Maryland, College Park
(Scholars Program)

Amy Zhang
University of Maryland, College Park
(Honors College)
Yale University*

Research Awards and Honors

The Regeneron Science Talent Search

Amy Zhang was selected as a National Scholar in the 2017 Regeneron Science Talent Search for her project "Self-Folding Motile Encapsulating Microdevices for Use in Single-Cell Analysis." Amy's research involved the modification of a cell sized mechanical tool called a microgripper. She did her work at the Johns Hopkins University Department of Chemical and Biomolecular Engineering and was mentored by Dr. David Gracias and Qianru Jin. Scholars were selected from more than 1,700 applicants hailing from 182 high schools in 36 states and three American and international high schools overseas. Since 2005 eleven Ingenuity at Poly students were named Intel/Regeneron semifinalists and three of them were named Intel winners.

Intel International Science and Engineer Fair (ISEF)

Alida Schott won third place in the Physics and Astronomy category at ISEF in Los Angeles, CA.

The Baltimore Science Fair

Stephen Grabowski was named the Grand Prize winner in the biological sciences category for his project "Dethiosulfovibrio Strain F2b, a New Non-Thiosufate Reducing Bacterium that Degrades Mariculture Waste." He went to Los Angeles, CA in May to compete at the 2017 ISEF.

Rebecca Brody won 1st place in the biological sciences category.

Alida Schott won 1st place in the physical science category and went to the 2017 ISEF in Los Angeles.

Amy Zhang received an Honorable Mention: certificate and medal.

Special Awards by Independent Groups

Society for Science & the Public Award for Community Innovation - **Claire Wayner**

United States Army Award of Merit for an Outstanding STEM Project - **Claire Wayner, Caterina Erdas**

Office Naval Research – Navel Science Award for Outstanding Scientific Achievement - **Claire Wayner, Amy Zhang**

National Society for Black Engineers, Special Achievement Award - **Claire Wayner , Mikell Meyers**

US Coast Guard Engineering Logistics Center - **Elijah Dukes**

National Organization of Gay and Lesbian Scientists and Technical Professionals, 1st Place Award - **Iven Chen-Van Dyk**, Honorable Mention - **Elijah Dukes, Ezra Szanton**

Society for In-Vitro Biology - **Elijah Dukes**

National Institute on Drug Abuse, NIDA, Intramural Research Program, 1st Place Award - **Sherry Bossard**, 2nd Place Award - **Moufie Adedoyin**

Society of Toxicology – National Capital Area Regional Chapter, 1st Place Award - **Elijah Dukes**, Honorable Mention Regional Science Fair Toxicology Award - **Rebecca Brody, Aishwarya Shettigar**

U.S. Stockholm Junior Water Prize Regional Award - **Claire Wayner**

American Institute of Aeronautics and Astronautics Mid-Atlantic Section - **Ezra Szanton**

United States Department National Oceanic and Atmospheric Administration - **Sherry Bossard**

International Council on Systems Engineering – Chesapeake Chapter, Achievement in Science and Engineering , 1st Place - **Amy Zhang**, 3rd Pace - **Robert Blanchard** , Honorable Mention - **Alida Schott**

Towson Fisher College of Science and Mathematics Dean's Award for Excellence in Science, 1st place - **Alida Schott**, 2nd place - **Rebecca Brody**

Research Awards and Honors

Maryland Junior Science and Humanities Symposium (JSHS)

Aishwarya Shettigar won 2nd place at the Maryland Junior Science and Humanities Symposium (JSHS) with her project "Studying Toxigenic C. Difficile as a Potential Inducer of Colon Cancer." Her Oral Presentation Award included a trip to San Diego for the National JSHS Competition.

Claire Wayner's 3rd place prize, as well as **Rebecca Brody's** 4th place, also included a trip to San Diego. **Stephen Grabowski** won 1st place in the Poster Presentation competition.

National Junior Science and Humanities Symposium

Rebecca Brody won 2nd place at the national competition in the category 'Biomedical Sciences, Molecular/Cellular' with the project "An In Vitro Model System for Studying the Effects of Hypoxia on Stem Cell-Derived Endothelial Cells."

Stockholm Junior Water Prize Competition

Claire Wayner won the U.S. Stockholm Junior Water Prize Regional Award at the regional level and was announced as the Maryland State Champion. She has been invited to compete at the Stockholm Junior Water Prize National competition in Charlotte.

North American Marine Environment Protection Association (NAMEPA) and the American Salvage Association (ASA) Science Fair

Stephen Grabowski's paper was awarded 3rd place prize at the Marine Science Paper Competition of American Salvage Association and North American Marine Environmental Protection Association. Stephen was invited to attend the awards dinner at PIER A in New York City.

2017 Maryland BioGENEius Challenge

Rebecca Brody's project "An In Vitro Model System for Studying the Effects of Hypoxia on Stem Cell-Derived Endothelial Cells" was the Maryland State Champion. She's invited to compete at the International BioGENEius Conference in San Diego, CA this June.

Claire Wayner's project was third place in Maryland State.

Northrop Grumman High School Innovation Challenge

3rd Place: **Robin Graham-Hayes, Anisa Hofert, Amy Zhang**

Mathematics Achievements

Future Scholars Program

Vivian Borbash, Alida Schott, Ezra Szanton and **Claire Wayner** have been accepted into the Future Scholars Program at the Johns Hopkins University Department of Mathematics and will take college math courses there next year.

University of Maryland College Park High School Mathematics Competition

Six Ingenuity students were invited to participate in Part II of the Competition:
Sigurd Biarnsson, Robert Blanchard, Andrew Frock, Yoav Kargon, Colton Ross and **Isaac Spokes**.

Robert Blanchard was the highest Ingenuity scorer in the competition.

Colton Ross ranked 86th in the State of Maryland in Part I of the competition.

American Mathematics Competition (AMC)

AMC10: **Colton Ross** is the school winner. 2nd and 3rd Place - **Wilfred Tsung** and **Gerson Kroiz**

AMC12: **Andrew Frock** is the school winner, 2nd and 3rd Place - **Yoav Kargon** and **Duncan Parke**.

As one of the top Maryland scorers, **Andrew Frock** was invited to the American Invitational Mathematics Examination (AIME). Only top 2.5% of scorers on the AMC 10 and the top 5% of scorers on the AMC 12. nationally are invited to participate in AIME.

Maryland Math League

Ingenuity best solvers include **Andrew Frock, Yoav Kargon, Gerson Kroiz, Colton Ross and Duncan Parke**.

Ingenuity team was 6th in the state, and **Andrew Frock** shared places 9 - 14 on the list of the highest scoring students in the state of Maryland.

800 SAT and SAT 2 Scores

Sigurdur "Ben" Bjarnason: 800 Math, 800 Math 2
Sarah Bowden: 800 Math
Andrew Frock: 800 Math 1, 800 Math 2, 800 Physics
Stephen Grabowski: 800 Math 2
Robin Graham-Hayes: 800 Math 2
Yoav Kargon: 800 Math, 800 Math 1, 800 Math 2, 800 Reading

Notable College Scholarships

2017 Baltimore Scholars

Nine Ingenuity students received scholarships to the Johns Hopkins University: **Sarah Bowden, Lauren Fink, Andrew Frock, Stephen Grabowski, Robin Graham-Hayes, Yoav Kargon, Aishwarya Shettigar, Monika Watat, and Sydney Worsham.**

UMBC Meyerhoff Scholar: Martin Orellana-Guzman

University of Maryland, College Park Banneker/Key Scholars; Andrew Frock, Yoav Kargon, and Aishwarya Shettigar

National Hispanic Scholar: Martin Orellana-Guzman

Duke University Alumni Endowed Undergraduate Scholarship: Yoav Kargon

Washington University in St. Louis Eliot Scholarship: Monika Watat

Boston University Richard D. Cohen Scholarship: Sydney Worsham

Yale University, Yale Scholarship: Amy Zhang

Howard University, Bison STEM Scholarship: Monika Watat

Boston College, BC Scholarship: Sigurdur "Ben" Bjarnson

To date, Ingenuity's Class of 2017 has earned over $8,666,358 in scholarships.

Ingenuity Award Descriptions

The Leadership Award is presented to one student in **each grade level** who has demonstrated outstanding leadership, as well as initiative in helping others and contributing to the welfare of the high school community, as noted by their peers and teachers.

The Comradery Award is presented to the student in **each grade level** who demonstrates amiability and a collaborative nature, as noted by their peers and teachers.

The Scholastic Balance Award is presented to the student in **each grade level** who demonstrates dedication to their extracurricular activities (e.g. sports, jobs, clubs, etc.) and effectively balances their activities with their school work, as noted by their peers and teachers. .

The Community Improvement Award is presented to the student in **each grade level** who demonstrates outstanding dedication to helping and giving back to their communities through hours of volunteering in school clubs or outside organizations, as noted by their peers and teachers. .

The Research Poster Award is presented to the student in **each grade level** with the most captivating research topic and excellent poster design as noted by faculty, staff, and students.

The 12th Annual Karol S. Costa Ingenuity Award is presented to the student in **each grade level** who demonstrates outstanding inventiveness, originality, and ingenuity in the classroom, as embodied daily by Ms. Costa, as noted by their peers and teachers. The Board of Directors established this award in 2005 in grateful recognition of Ms. Costa's contribution as the Founding Director of the Ingenuity Project.

The Stephanie Franklin Miller Research Scholarship is presented to the **junior** who has demonstrated outstanding dedication to research and the overall significance of their science research. This award is presented by Ms. Miller who selected this student based on a written submission. The award has been established by Ms. Miller's family in recognition of her career-long dedication to education, notably her service as Ingenuity's first science curriculum coordinator.

The Highest Average Awards in Mathematics and Science are presented to the student in each math and science class who has earned the highest average in the class.

Seniors Only

The Science Achievement Award is presented to the **senior** who has consistently demonstrated outstanding overall achievement in science.

The Mathematics Originality and Creativity Award is presented to the **senior** who has broadened the knowledge of the class as a whole by proposing innovative methods of solution and unique perspectives regarding seemingly ordinary problems as determined by the primary mathematics teacher.

The Mathematics Problem Solving Award is presented to the **senior** who consistently has demonstrated advanced topical skill and has received outstanding competition scores, as applicable as determined by the primary mathematics teacher.

The STEM Achievement Award is presented to the **senior** who has distinguished himself or herself by exceptional work in computer science, computer engineering, or data science in or out of class.

The John Claude Saylor Research Scholarship is presented to the **senior** who has demonstrated the greatest devotion to the ideals of the research program - earnest and consistent effort and the intrinsic motivation to obtain the greatest learning experience possible from the research experience as determined by peers and teachers in the Research Practicum Program.

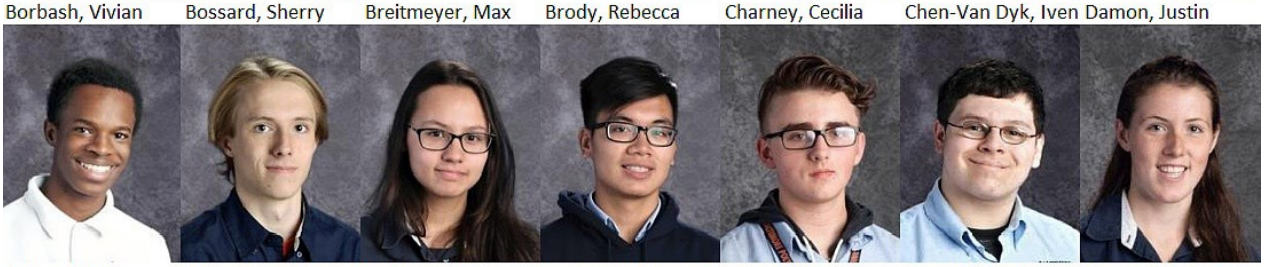
The Nancy Forgione Humanities Scholarship is presented to the **senior** who has demonstrated outstanding achievement in social science and humanities as noted by his or her humanities and social science teachers. The Hill family (Owen, class of 2006 and Albert, class of 2003) established this award in loving memory of their mother.

The Dolores Costello Tenacity & Grit Award is being presented to the **senior**, who despite encountering challenges, has demonstrated the perseverance, effort, self-advocacy, resiliency and passion to achieve long-term academic and personal goals. This award was established by the Board in 2014 in recognition of the long-term commitment of Dolores Costello.

Seniors
2013-2017

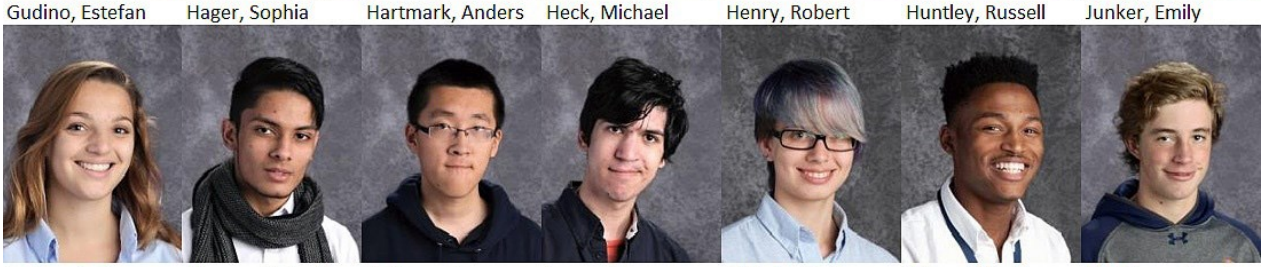
Adedoyin, Moufidatou | Amata, Dexter | Batchelor, Lily | Bernier, Audrey | Bishwokarma, Shiwani | Blanchard, Robert | Blazey, Sebastian

Borbash, Vivian | Bossard, Sherry | Breitmeyer, Max | Brody, Rebecca | Charney, Cecilia | Chen-Van Dyk, Iven | Damon, Justin



Dukes, Elijah | Easton, Xander | Erdas, Caterina | Evangelista, Joseph | Geiger, Jace | Good, Nicholas | Greene, Hannah

Gudino, Estefan | Hager, Sophia | Hartmark, Anders | Heck, Michael | Henry, Robert | Huntley, Russell | Junker, Emily



Junker, Sydney | Kamran, Faheel | Li, Alexander | Lyons, Azeem | Miciche, Hailey | Myers, Mikell | Noffsinger, Jacob

Parke, Duncan | Parker, Phoebe | Pierce, Conor | Roundtree, Jaylin | Rugerio-Mejia, Belen | Schott, Alida | Shalby, Mahmoud

Simko, Ian | Spokes, Isaac | Szanton, Ezra | Thomas, William | Thompson, Mercedes | Watford, Justin | Wayner, Claire

Class of 2018
2014-2018

Ahmed, Sumaita | Allston, Ayden | Alper, Nathaniel | Anderson, Erika | Berry, Amanda | Booker-Godfrey, Taylor | Brooks, Roger

Calderon, Matias | Caverly, Keara | Clark, Khayree | Cole, Chelsea | DeBell, Lily | Dillow, Brandon | Francois, Evains

Frock, Christopher | Glaros, Corbett | Goldsmith, Lily | Griffin, Karen | Halpin, John | Harkness, Samuel | Henley, Camille

Holland, Ula | Honablew, Timothy | Howarth, Michael | Hudnall, Faith | Kane, Rohan | Lai, Ryan | LaVorgna, Cecilia

Legaspi, Raquel | Martin, Ruth | McCullum, Chenille | McIlwain, Daisha | McKenna, Abigail | Mokaya, Michelle | Mwangi, Adi

Odedoyin, Omobolade | Onyeje, Chiad | Owens, Ifasoke | Pearson, Christian | Pontious, Rachel | Rivera Lavaire, Nayely | Rodesno-Hercules, Henry

Tsung, Wilfred | Weiss, Alyssa | Young, Taylor | Zheleznyakova, Elizaveta

Class of 2019
2015-2019

Class of 2020
2016-2020

Acknowledgements

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