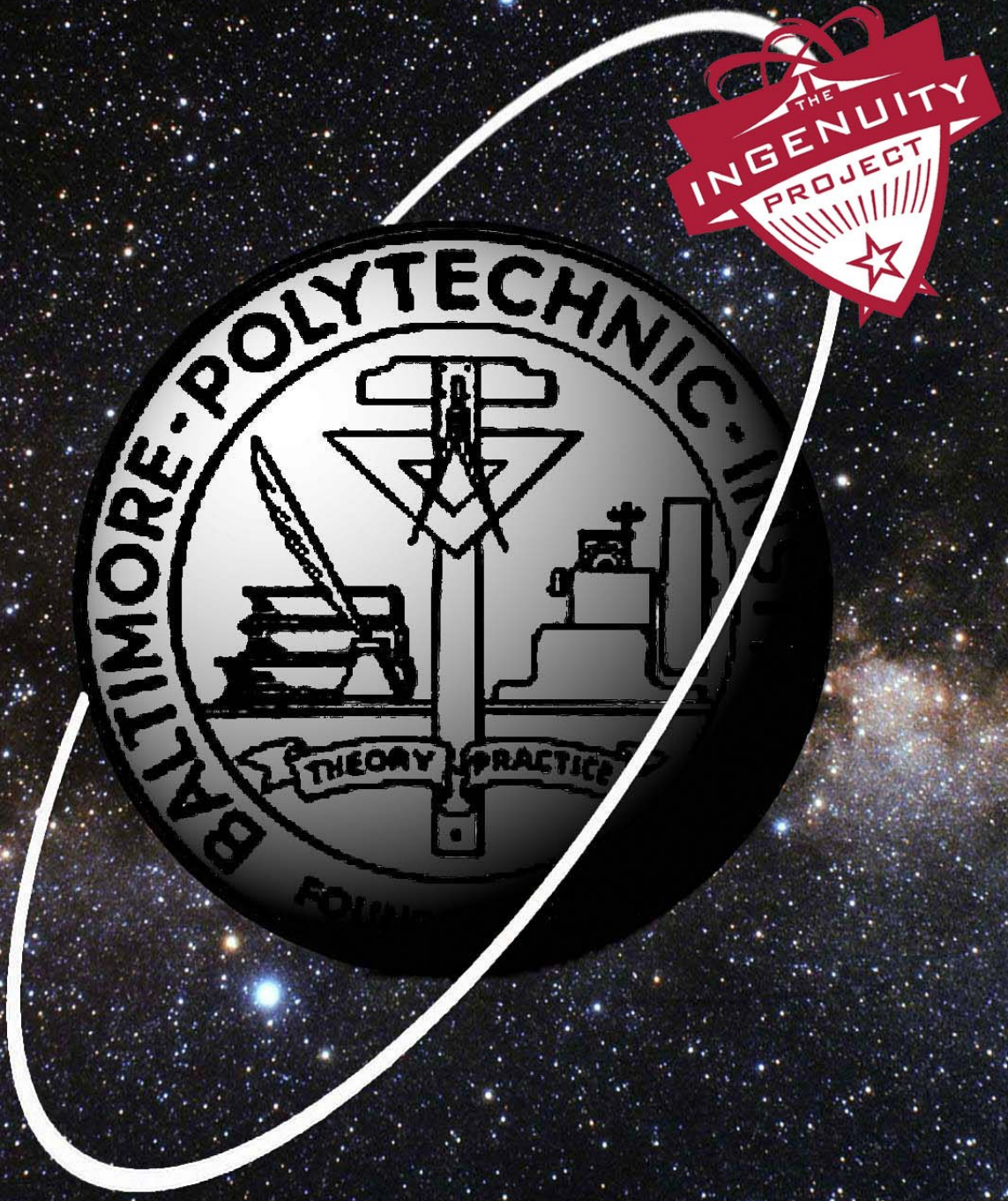
14th Annual Ingenuity Math | Science Symposium



May 27, 2016

Baltimore Polytechnic Institute

Table of Contents

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 four-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.

To qualify for and remain in the Project, Ingenuity students must have excellent attendance, with no unexcused absences 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 the sophomore to senior years, 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 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.

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.

Schedule of Events

3:30-5:00 Middle School Capstone Exhibition (projects on display in room 124 after 5 pm)
5:00-6:10 Poster Viewing and Refreshments
6:15-6:35 **Banneker Hall** - Opening Comments
Britni Lonesome: IBM Cloud Advisor & Poly '06
MCs: *Jasmine Long and Robin Graham-Hayes*

PRESENTATIONS

6:40-6:55 **Banneker Hall** - Activating mutations in FGFR leads to a competitive advantage in Drosophila germline stem cells
Kathy Le
Room 119 - Collection and Analysis of Data from Question and Answer Threads on Quora
William Povell
Room 120 - A Model for Wholesaler-Corner Store Interactions in Low-income Neighborhoods in Baltimore
Harry Huntley
Room 121 - Fibonacci & Tribonacci
Aaron Fink

7:00-7:15 **Banneker Hall -** Drones Equipped with LiDAR for 3D Mapping
Alex Hilger
Room 119 - Investigation of the Relationship between Osteopontin (OPN) and the HIV-1 IIIβ gp-120 Envelope Protein Regarding Axonal Length/Growth, and Cytotoxicity in the SH-SY5Y Cell Line
Simon H. Benzer
Room 120 - Stereometry: Basic Theorems and some problems
Ben Garlow & Kyle Low
Room 121 - The Effect of ErbB2 and its Localization on Cardiac Function and Structure
Cullen Bray
Room 125 - Extensive Analysis on the History of Poly's Math Exams
Rebecca Gearhart & Faith Wilkins

7:15-7:25 BREAK

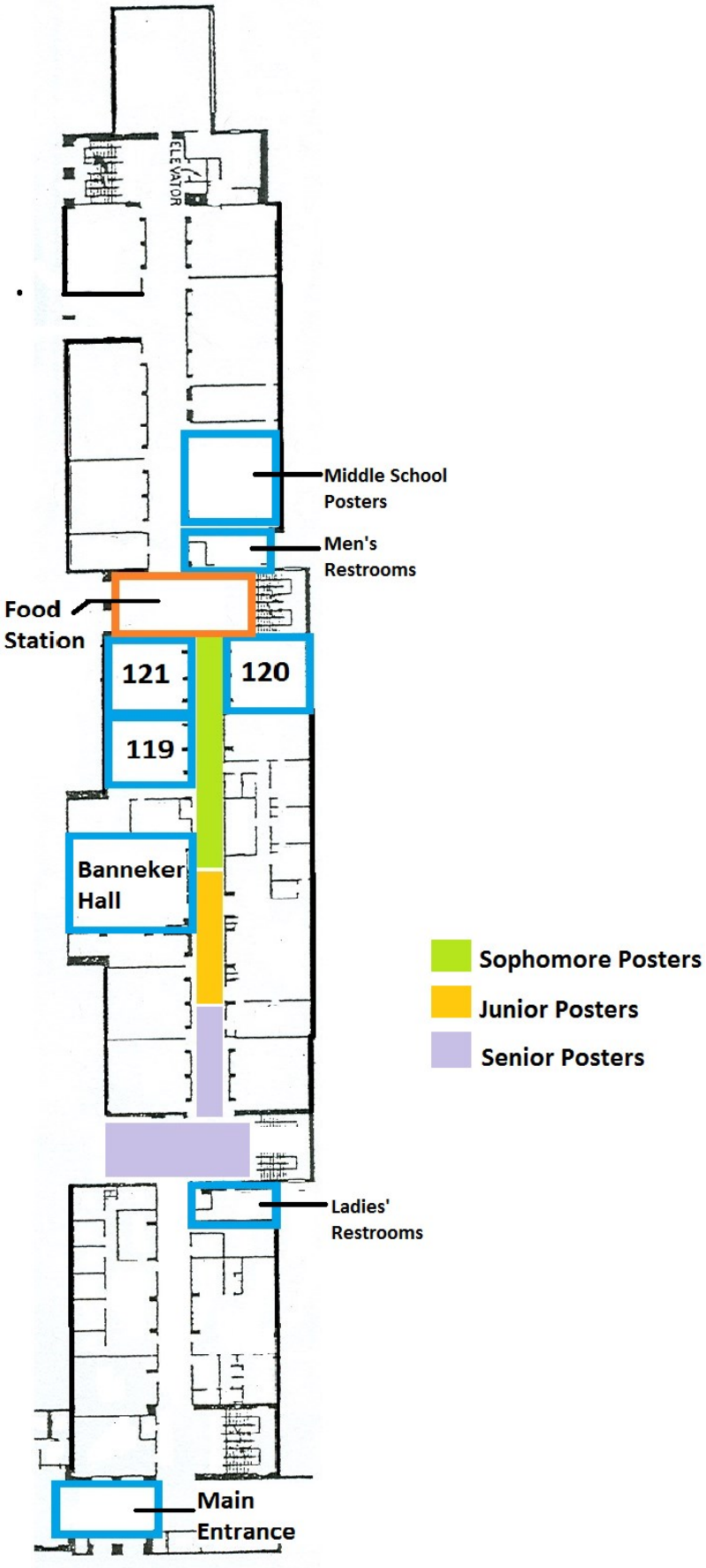
7:25-7:40 **Banneker Hall** -Fourier Series
Max Yuhas & Will Povell
Room 119 - Expression of C9orf72 and SMCR8 in E. coli Cells
Si Lin
Room 120 - Encrypting Python Files
Yitzhak Oshry
Room 121 - Excavation and Analysis of an Endangered Prehistoric Native American Site
Luc Renaux

7:45-8:00 **Banneker Hall -** CT reconstruction of Ediacaran trace fossils
Humza Yaqoob
Room 119 - Advanced Upper-Limb Prosthesis Control Scheme using a Privatize Myoelectric Armband and a Virtual Prosthesis Program
Eterick Stonely
Room 120 - Trigonometry & Calculus
Kathy Le & Yitzhak Oshry
Room 121 - Properties of Squeers
Thomas Heck & Harry Huntley

AWARDS CEREMONY

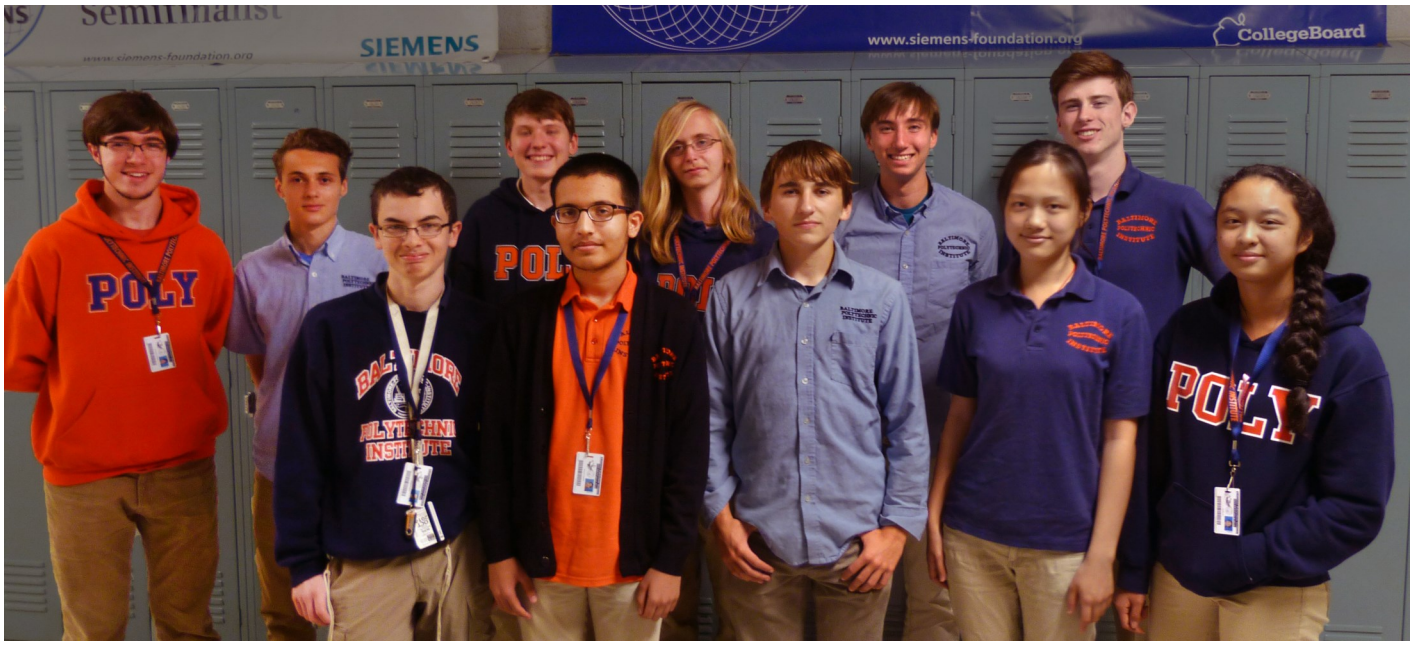
8:05-8:45 **Banneker Hall**
MCs: *Stephen Grabowski and Amy Zhang*

Map


ELEVATOR
Middle School Posters
Men's Restrooms
Food Station
121
120
119
Banneker Hall
Ladies' Restrooms
Main Entrance
Sophomore Posters
Junior Posters
Senior Posters

Senior Research Abstracts

The seniors' presentations represent the culmination of their research efforts. Students completing Ingenuity Research Practicum with Mr. David Nelson worked with members of the scientific community for fifteen months during 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, Intel Science Talent Search, and Junior Science and Humanities Symposium. (Note: some Ingenuity students elect to take Research Practicum during their senior year.)



From Left: Eterick Stonely, Simon Benzer, Yitzhak Oshry, Luc Renaux, Humza Yaqoob, Cullen Bray, Will Povell, Harry Huntley, Si Lin, Alex Hilger, Kathy Le

Senior Research Abstracts

Investigation of the Relationship between Osteopontin (OPN) and the HIV-1 IIIβ gp-120 Envelope Protein Regarding Axonal Length/Growth, and Cytotoxicity in the SH-SY5Y Cell Line

Simon H. Benzer

Mentor: Dr. Amanda Brown
Institution: Johns Hopkins NIMH Center for Novel Therapeutics for HIV-associated cognitive Disorders

Numerous individuals infected with HIV become affected by cognitive impairments known as HIV-associated neurocognitive disorders (HAND). Osteopontin (OPN), a pro-inflammatory cytokine, was found be in elevated concentrations, prompting research on the relationship shared between HIV and OPN. In an effort to analyze this, the Neuroblastoma cell line SH-SY5Y was used to investigate the relationship between OPN and axonal length/growth, as well as cytotoxicity. Various concentrations of OPN were introduced to SH-SY5Y cultures with, and without, the presence of HIV-1 IIIβ gp-120 envelope protein. Aliquots of the aforementioned cultures were used to perform the cytotoxicity assay. These findings indicate that OPN affects axonal length in cells introduced to HIV envelope proteins. Additionally, the cytotoxicity assay performed suggests a relationship between OPN and cytotoxicity, but this will require corroboration.

The Effect of ErbB2 and its Localization on Cardiac Function and Structure

Cullen Bray

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

ErbB2 is an important signaling protein in cells that is responsible for the signaling of the β-adrenergic stress response. When this protein is overexpressed in mice, they proceed to have cardiac infarctions, and when it is blocked it leads to cardio-toxicity that causes problems in the function of the heart. This paper presents results from an effort to explore the interaction between ErbB2 and its downstream proteins, the localization of this protein, and ErbB2's effect on the structure of the heart as a whole. Additionally, in order to quantify the change in structure due to ErbB2 overexpression, a way of staining and measuring tissue area is introduced.

Senior Research Abstracts

Drones Equipped with LiDAR for 3D Mapping

Alex Hilger

Mentor: Mark Dhruv
Institution: EA Engineering, Science and Technology, Inc., PBC

A LiDAR laser measurement sensor and a survey grade GPS (dual units with yaw, pitch and roll gyroscope) were connected to an on-board computer with mapping software and mounted on a drone to provide precise elevation data for making land contours, in the same manner as manned aircraft. Drones are safer, dramatically less expensive, and the quality of data collected is far superior, because drones can fly much closer to the ground and in areas inaccessible to conventional aircraft. Light detection and ranging (LiDAR) measures the time it takes light to bounce off the earth and return to the sensor - at 300,000 light pulses per second, 250 elevations per square foot. The sensor can gather 250 million points in 15 minutes of autonomous flying and create topographical maps with high accuracy through software rendering. Drones equipped with LiDAR will revolutionize agriculture, archeology, construction, defense contracting, forestry, industrial inspections, land surveying, and mining. This is all possible through advancements in drone, GPS, and LiDAR technologies that have dramatically reduced the cost and expanded the applications.

A Model for Wholesaler-Corner Store Interactions in Low-income Neighborhoods in Baltimore City

Harry Huntley

Mentor: Joel Gittelsohn
Institute: Johns Hopkins Bloomberg School of Public Health

Like many urban areas throughout the country, low-income neighborhoods of Baltimore City are disproportionately affected by obesity, which leads to many health issues including diabetes, heart disease, and even cancer. One main reason for obesity in these communities is a lack of available healthy food. The B'More Healthy Communities for Kids (BHCK) project works on many levels to prevent obesity in Baltimore. One of the strategies is to increase access to healthier foods in corner stores, the main food source of the neighborhoods, in which the project operates. Corner stores purchase food at lower, bulk prices from wholesale stores in and outside of Baltimore City. Therefore, ensuring wholesale stores offer healthy foods is critical to improving the food environment in the target neighborhoods. This project studied the implementation of the wholesale component of BHCK. From that evaluation, this project proposes the most effective plan for an intervention to use the relationship between wholesale and corner stores to bring healthy food into neighborhoods and decrease obesity.

Senior Research Abstracts

Activating mutations in FGFR leads to a competitive advantage in Drosophila germline stem cells

Kathy Le

Mentors: Ms. Leah Greenspan/ Dr. Erika Matunis
Institute: Johns Hopkins School of Medicine

The Paternal Age Effect describes how older men are more likely to have children with genetic disorders than younger men. This is attributed to an age-related accumulation of sperm with spontaneous mutations that are thought to originate in germline (sperm-producing) stem cells (GSCs). Advantageous mutations in stem cells can out-compete other stem cells; however, competition between GSCs is still poorly understood. Using the *Drosophila melanogaster* as a genetic model, we find that over-activating the breathless (btl) receptor tyrosine kinase, a homolog of the fibroblast growth factor receptor (FGFR) and a component of the MAP-Kinase (MAPK) signaling pathway, causes mutant GSCs to appear more frequently than non-mutant GSCs, suggesting that this mutation confers a competitive advantage. In contrast, activating mutations in other components of the MAPK pathway—Raf, Ras, and heartless (htl), another FGFR homolog—did not result in more mutant GSCs than non-mutants. Since only a few genes are known to lead to Paternal Age Effect disorders, we also introduce a screening approach that can effectively discover other advantageous mutations in GSCs. Further uncovering the mechanisms that underlie the Paternal Age Effect disorders will be a prerequisite for finding ways to prevent mutation accumulation and genetic defects.

Expression of C9orf72 and SMCR8 in *E. coli* Cells

Si Lin

Mentor: Dr. Janet Ugolino, Ph.D.
Institute: Johns Hopkins School of Public Health Dept. of Biochemistry and Molecular Biology

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease that affects motor neurons in the brain and the spinal cord. Symptoms of the disease include muscle wasting, speech impairment, paralysis, and eventually death from respiratory failure. *C9orf72* is a gene whose mutation is linked to ALS, but little is known about how the mutation leads to the disease. One way to gain further insight into the pathway through which *C9orf72* mutation leads to ALS is by analyzing C9orf72 interaction with its binding partner, SMCR8. To do this, both SMCR8 and C9orf72 must first be available for research. The goal of this project was to express both SMCR8 and C9orf72 as soluble proteins in modified BL21 *E. coli* cells and isolate them. Results suggest that both SMCR8 and C9orf72 are soluble proteins when coexpressed. Further experimentation is required to verify the results, but if both SMCR8 and C9or72 are indeed soluble, then the next step would be to find the crystal structure of each protein. Analysis of the protein crystal structure allows for greater insight into protein function, which is also essential for understanding how *C9orf72* mutation leads to ALS.

Senior Research Abstracts

Encrypting Python Files

Yitzhak Oshry

Mentors: Paul Martin and Dr. Avi Rubin
Institute: Johns Hopkins University Information Security Institute

Python has become a widely used programming language, yet since it is designed as an interpreted language, it lacks decent built in obfuscation for its bytecode. This hinders the ability to safely distribute Python code without it being hacked or pirated. I attempted to create a program to encrypt Python files using an AES Python encryption library called PyCrypto, and a password to store the key. I built a separate program to analyze the encrypted file, decrypt it and execute the decrypted file at runtime. The importance of executing the files at runtime is to bypass the need to save the unencrypted script to a separate file. The encryption provides an increased level of security compared to Python's bytecode, yet the encryption program is still an open Python file and can still be edited by the user to retrieve the original program. Therefore, in order to make this process completely secure, the encryption/decryption program should be compiled to machine code.

Collection and Analysis of Data from Question and Answer Threads on Quora

William Povell

Mentors: Frank Ferraro and Dr. Matt Post
Institute: Johns Hopkins University Department of Computer Science

Q&A forums contain a wealth of data that is useful for training machine learning models to solve natural language processing tasks. However, large amounts of this data must be collected and processed first. Over three months, more than 114k Q&A threads have been collected from the website quora.com, including text and metadata on user posts. This data has been processed and the calculation of descriptive statistics has been performed on it. A task of predicting whether or not a user question would be answered based on its textual features was attempted. Using standard techniques, an accuracy of 66% was achieved, beating a naive baseline of guessing the most common class, which reached only a 62% accuracy. This new accuracy result can act as a more rigorous baseline in the future when applying novel techniques to the prediction task. Future work will focus on making further predictions, such as how long it will take for the question to be answered and how many up votes a given answer will receive.

Senior Research Abstracts

Excavation and Analysis of an Endangered Prehistoric Native American Site

Luc Renaux

Mentor: Ms. Stephanie Sperling
Institute: Lost Towns Project

With rising sea and flood levels, many cultural sites located near waterways are in danger of destruction. One such site is the River Farm site, a prehistoric Native American site on the bank of the Patuxent River in Southern Anne Arundel County, Maryland. Preliminary excavations were conducted to determine the extent, time period of use and habitations, and guide placement of more extensive excavation units. The artifacts excavated (ceramics, lithics, fire-cracked rock, and projectile points) were compared to carbon-dated artifacts from nearby sites in order to determine the age and type. Distribution maps for each type of artifact were created to visualize the extent of activities at the site. The frequency and percent distribution of artifacts by weight were also calculated. The majority of named prehistoric ceramics discovered came from the Late Woodland period (1000 - 1500 C.E). Diagnostic stone points suggest a site age of up to 9000 - 8000 B.C.E and the presence of exotic stone material suggest trade occurred at the site. A site boundary, other than the natural boundary of the river, could not be determined as artifacts were present in all but two of the of the shovel test pits. The results support the view of the Chesapeake Bay as a large hub of Native activity in prehistoric times, and add to the history of the region as a whole.

Advanced Upper-Limb Prosthesis Control Scheme using a Privatized Myoelectric Armband and a Virtual Prosthesis Program

Eterick Stonely

Mentor: Megan Hodgson
Institute: Infinite Biomedical Technologies

The structure and function of the human body's upper limbs are complex, particularly the hand and wrist, which are essential to almost all human activities. These biological structures have yet to be completely replicated through mechanical means, leaving amputees at a disadvantage to whole-bodied individuals. However, research is being done to develop technologies to benefit upper limb amputees more than ever before. Upper limb prosthetic systems utilize myoelectric technologies capable of reading nerve impulses sent from the central nervous system to the peripheral nervous system, to then induce muscle actions. The systems use skin surface electrodes to detect these impulses and send them to a processing unit that evaluates which gesture an amputee is making. The prosthesis then replicates the detected gesture for the amputee to use. My efforts were to connect a computer program environment that simulates an upper limb prosthesis, with an external array of electrodes, through the use of Bluetooth technology and Lua Scripts. With such a system, researchers would be able to more readily manipulate different parts of either the prosthesis or the electrodes to conduct research, actions that are much more difficult and costly to carry out with physical hardware components.

Senior Research Abstracts

CT reconstruction of Ediacaran trace fossils

Humza Yaqoob

Mentors: Dr. Linda Hinnov and Dr. Michael Meyer
Institutes: George Mason University, Department of Atmospheric, Oceanic and Earth Sciences; Carnegie Institution of Science, Geophysical Laboratory

A significant increase in the diversity and complexity of bioturbation occurred at the transition between the Ediacaran and Cambrian geological periods in an event commonly known as the "Agronomic Revolution." Most trace fossils from the Ediacaran period that represent burrows are relatively simple, whereas Cambrian trace fossils from after the Agronomic Revolution demonstrate more complex burrowing behavior. *Lamonte trevallis* is an ichnospecies found in the Shibantan Member of the upper Ediacaran Dengying Formation, in the Yangtze Gorges region of South China. Compared to *L. trevallis*, most trace fossils from the Shibantan Member are relatively simple, making this ichnospecies a subject of interest with regard to understanding the Agronomic Revolution and late Ediacaran ecosystems. Using X-ray CT technology, a sample of *L. trevallis* was scanned in order to observe the internal morphology of the fossil in situ. The data collected from the scan were used to generate digital images clearly depicting the internal features of the *L. trevallis* specimen. From these images, a preliminary 3D model was constructed through the segmentation of regions of interest representing components of the *L. trevallis* traces. This model will be used to obtain information about the trace maker that is unavailable solely from external observations and to better understand late Ediacaran ecosystems.

Senior Practicum

The following students elected to take Research Practicum during their senior year with Ms. Sally Kutzer. They presented their results to a public audience at the Baltimore Science Fair in March and at Poly on April 28, 2016. In addition to poster competitions and presentations, students also produced a final scientific or technical paper on the results of their research.

Shoshana Brody
Do Exercise-Associated Injuries Induce the Activation of Tendon Stem Cells?

Becca Gearhart
Characterizing the Association between Diabetes and Cognitive Impairment

Thomas Heck
The *cis*-regulation of *Sex lethal* in the *Drosophila melanogaster* Germline

Cresangelo Legaspi
Oil-Infused Micropillars as Bioinspired Wet Adhesives

Jakob Lucas
A Statistical Analysis of the Predictors of Motor Symptom Severity in Parkinson's Disease Patients Measured by the Hoehn and Yahr Score

Ema Pagliaroli
Microalgae and Associated Bacteria for Biofuel Production

Lauren Roundtree
Targeting C5 Methylation of DNA to Hypomethylated Promoters Associated with Disease

Faith Wilkins
Measuring the Mutation Rate of *Cs*RV1 in Blue Crabs, *Callinectes sapidus*

Max Yuhas
Stability and Cooperativity of Designed Helical Repeat 54

Senior Math Projects

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

Tribonacci

Aaron Fink

The Fibonacci sequence is one of the most famous pieces of mathematics, and for good reason. Its properties happen to describe countless natural phenomena. First, I used algebra to turn the iterative definition for the sequence into an explicit one. Furthermore, I generalized this approach to work for tribonacci sequences, and n-binocci sequences, with any ordered set of n starting values. I also explored definitions of these series which took the form of recursive matrix multiplication, similar to geometric progressions. This approach allowed me to uncover properties of the sequences, and to graph them by using successive sets of adjacent terms as coordinates in 2 and 3-dimensional planes.

Stereometry

Benjamin Garlow and Kyle Low

Stereometry, or three dimensional geometry, is the study of lines, planes in space, and solid bodies. Stereometry is not just using the theorems and properties of two dimensional euclidian geometry in three dimensional space, but has its own theorems and properties that are unique. The main resource used in this math project is an old Russian textbook titled *Geometry: Book II. Stereometry* written by Andrei Kiselev and translated by Alexander Givental. The obtained results of the project are the proof for the Theorem of Two Perpendiculars, the proof for the Theorem of Three Perpendiculars, and the solutions to two problems specifically related to stereometry. The results were all derived from theoretical mathematical principles, but can be applied to real-world situations dealing with the measurement of solid bodies.

Extensive Analysis on the History of Poly's Math Exams

Faith Wilkins, Becca Gearhart

Baltimore Polytechnic Institute's mathematics curriculum has undergone a major shift in the importance of topics taught. Today, linear algebra, advanced forms of trigonometry and difficult proofs in geometry are not included in the mathematics curriculum. With that said, we chose a few problems from the old mathematics placement exams and showed that without learning advanced topics in calculus, today's average student at Poly wouldn't be able to solve them correctly. We ended up using De Moivre's theorem to prove a trigonometry problem. From an analysis of the math placement exams from 1963, we concluded that even though a small percentage of Poly's students reach some higher levels in mathematics, most would have difficulty solving some of the older exam problems. This goes to show that our predecessors at Poly had a different math curriculum than we do today. Today's advanced Poly students have an extensive knowledge of Calculus and many Poly graduates start their college math work taking Calculus III (multivariable calculus).

Senior Math Projects

Squares and Squeers

Harry Huntley and Thomas Heck

The project deals primarily with the geometric shapes “squeers”. Squeers are defined as quadrilaterals with equal and perpendicular diagonals. In addition, the topic of complex coordinates (coordinates representing the placement of points by complex numbers) will be introduced. The project uses complex coordinates to prove that the centers of four squares constructed on the sides of any quadrilateral form a squeer. As part of this project, other properties of squeers are discussed, such as being able to perform this same operation infinitely to get a square as the figure formed, instead of a squeer.

Trigonometry in Calculus

Yitzhak Oshry, Kathy Le

In our Calculus classes at Poly, students learn the basic methods to evaluate various integrals. While students often rely on their algebra skills to solve some of these problems, the huge overlap between trigonometry and calculus in the real world of mathematics has largely been overlooked by the curriculum. Thus, students find that they are unable to solve many mathematical equations and problems in calculus. In our presentation, we will explore how trigonometry can be used to simplify these problems. We can convert a complex problem into a simple problem with trigonometric functions. We can also use trigonometric substitution to convert a complex integral or derivative problem into simple functions which can be easily solved. This shows that trigonometry is instrumental in simplifying and solving many calculus problems.

The Fourier Series

William Povell, Max Yuhas

The Fourier series is an expansion of a periodic function as an infinite sum of sin(nx) and cos(mx). It has many applications in fields such as signal processing and numerous areas of mathematics. The series relies on the orthogonality of the functions to represent any periodic function, including discontinuous functions, making the series unique compared to others like the Taylor series. In our project we prove the orthogonality of sin(nx) and cos(mx), as well as derive the coefficients for each term in the series. We then use the series to represent some basic periodic functions and then apply the series to more complex problems, for example to evaluate the sum of inverse squares.

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.

From Left: Jasmine Long, Sydney Worsham,, Olivia Birkel, Yoav Kargon, Ben Bjarnason, Anisa Hofert, Emma Eklund, Aishwarya Shettigar, Amy Zhang, Jacob Smith, Robin Graham-Hayes, Nick Eusman, Andrew Frock, Sydney Rosebrough, Stephen Grabowski, Sam Niziolek, Sam Smith, Branden Etienne, Julianna Lucas

Junior Research Abstracts

Evaluation of cribriform foramina in relation to dietary habits of various species within Lemuroidea

Olivia Birkel

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

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). The 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 studies on primate adaptations suggest that the size of the olfactory nerves may be affected by habit 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 will be measured with the use of skeletal models and 3D imaging/ processing software. This experiment is being conducted to analyze the connection between the various preferred diets of species from *Lemuroidea* and the varying size of their corresponding foramina. If it is found that the size and number of the foramina increase as the difficulty of locating a food source increases, then sense of smell should differ depending on the particular diet a species has.

Success of Technical Analysis Techniques on Stock Market Returns

Ben Bjarnason

Mentor: Dr. Daniel Naiman
Institution: JHU Department of Applied Mathematics and Statistics

There are two factions of investors involved in the stock market. Fundamental analysts work to understand the underlying value of an asset, in order to make relatively long term gains. They rely on information about a business, such as income statements and balance sheets, to predict if a stock is likely to succeed. Alternatively, technical analysis looks towards the past performance of the stock in order to predict the future prices. This can be done with price charts, formulas, and statistics. There are disputes over the effectiveness of technical analysis because of the efficient market hypothesis, which says that predictable patterns cannot exist in the market. Past research into technical strategies has shown mixed results, but there are many technical analysis tools to be tested. This project looks at the returns generated by one formula called the Relative Strength Index (RSI), which looks to find periods of time when the stock is moving strongly up or down. They predict that the price will not continue with strong trends and will reverse. Testing this will help stock market participants to make more informed decisions.

Junior Research Abstracts

Mapping and Explaining Baltimore's Urban Heat Island

Emma Eklund

Mentor: Dr. Benjamin Zaitchik
Institution: JHU Department of Earth & Planetary Sciences

The urban heat island effect (UHI) is an anthropogenic phenomenon that causes the temperature in an urban area to be higher than a rural one. The purpose of this project was to show UHI by using temperature data, and to use the temperature in order to see if there are correlations between it and other factors. The Landsat 8 satellite contains a thermal infrared sensor from Band 10, which measures the heat of the ground. GIS (geographic information system) was used in order to generate values for buildings, vegetation, elevation, population, and impervious surfaces in Baltimore. Land surface temperature (LST) was found by correcting the Landsat 8 image through a series of steps: converting the DN (digital number) and going through both emissivity and atmospheric corrections. The map of LST in Band 10 suggests that there is an urban heat island in Baltimore, since the highest temperatures came from the city. It was seen that building area, impervious area, and population were positively correlated with temperature. Vegetation and elevation had a negative correlation with temperature. This research shows that there is a relationship between LST and these five factors in Baltimore, where impervious surfaces have the highest correlation. This identifies the factors that increase temperature, and could be helpful for mitigation strategies.

Sleep Apnea at Altitude

Branden Etienne

Mentor: Dr. Luu Pham
Institution: John Hopkins Medicine Sleep Disorders Center

Sleep apnea is a common disease where a person, while asleep, is not breathing and this usually alarms the brain and forces the person to awaken from sleep. Due to the fact that sleep apnea relies on the availability of oxygen, we'd expect people at high altitude to have severe sleep apnea, however previous studies have used a small sample size of people living at high altitude it would be beneficial to do a study with a large sample size to better characterize sleep apnea at altitude. It was decided to study residents of Puno, Peru, located at an altitude of 3830 m, as a good representation of high altitude conditions, performing an ApneaLink experiment on 206 residents. Use of an Apnea Link device records the various vital signs of the test subjects, with the relevant ones being flow of oxygen into airways, effort of the body to breathe, saturation of oxygen, and the pressure exerted on lungs. We expected to see a high prevalence of sleep apnea at high altitude, because the thin air at altitude would cause the subjects' Sp02 (the saturation of blood with oxygen) to be low. After data was collected, it was scored by the Sleep Study Scorers using Remlogic and using a criteria made and discussed by the team. We found that Puno residents had a high AHI, which is the average number of apneas and hypopneas per hour, showing that they had very severe sleep apnea. We could then conclude that altitude and its hypoxic conditions is associated with a prevalence of sleep apnea. This study would help to expand what we know about the physiology of sleep apnea at altitude and to develop treatment methods.

Junior Research Abstracts

Accuracy improvement in the da Vinci Surgical System

Nick Eusman

Mentor: Peter Kazanzides
Institution: JHU Department of Computer Science, SMARTS lab

The field of surgical robots in minimally invasive surgery is constantly growing due to increased accuracy in robotics technology when compared to standard procedures and the ability of surgical robots to tackle previously impossible procedures. The use of multiple small incisions also reduces recovery time and chance for infection. Along with the field's growth comes an expansion in the amount of research done to better the practices of surgical robotics. One such system used to control a standard surgical robot for research purposes is the da Vinci Research Kit (dVRK). The dVRK is used in conjunction with the da Vinci surgical robot itself, a robot which has garnered international use throughout the past decade. The following presents a system by which users of the dVRK robotic surgical assistant can greatly improve the accuracy of the da Vinci's potentiometer sensor measurements. By creating an easy to use calibration process, users can increase the accuracy of three different elements of the robot: Master Tool Manipulators (MTMs), Endoscopic Camera Manipulators (ECMs), and Patient Side Manipulators (PSMs). This calibration process helps to improve overall accuracy of the robot by adjusting its potentiometers, which the robot is reliant upon for accurate positional data on startup. This straightforward system can be downloaded as a software package by any of the 20+ labs using the dVRK to improve the accuracy of the system itself.

Photoelectron Spectrometry with an Electrospray Ion Source

Andrew Frock

Mentor: Dr. Kit Bowen
Institution: JHU Department of Chemistry

Photoelectron spectrometry is a technique used to study many characteristics of atoms and molecules, including oxidation states, isotopes, and bond strengths. To use this technique, the compound must be an ion in the gas phase. Electrospray is a technique to reliably transfer dissolved ions into the gas phase. Dissolved ions are sent through a charged capillary tube to remove the undesired counterparts, and are then ejected into the chamber. Coulombic explosions break the solution into tiny droplets, which are heated to remove the solvent. This technique allows for the collection of photoelectron spectra from compounds such as complex organic molecules that are difficult to grow as crystals or to vaporize without decomposition.

Junior Research Abstracts

Autonomy and its Application to Modular Self-Assembling Systems

Robin Graham-Hayes

Mentors: Dr. Greg Chirikjian, Yuttana Itsarachaiyot
Institution: JHU Department of Mechanical Engineering, Robots and Protein Kinematics Laboratory

Autonomy and sensor systems are important factors in many modular and self-assembling robotics. Modular robots are made of many modules that fit together either to work together or to compose a system. A self -assembling robot is one that, through autonomy (the ability of the robot to be self-reliant), can assemble, add onto or create a copy of its self. For this project, a module-capable robot was created, one that has systems of sensors in order to demonstrate tracking and object avoidance skills as well as autonomy. This design approach allows robots to react on their own, creating an intelligent robots that can respond to issues as they come up, without the need for human input. Future work will focus on the creation of a module-capable linear encoder, using Hall Effect (magnetic field) sensors, for the purpose of relative distance detection. This system will be implemented on a large self-assembling robotic system to increase the level of autonomy in the system.

Sustainable Aquaculture through Environmental Microbiology: Degradation of Saline Fish Waste into Methane Biogas by Marine Microorganisms

Stephen Grabowski

Mentor: Dr. Kevin R. Sowers
Institution: The Institute of Marine and Environmental Technology (IMET)/UMBC Department of Marine Biotechnology

Fermentative bacteria from marine sludge often display the capacity to metabolize proteinaceous substances in a saline environment. As such, they offer much potential for use in a recirculating aquaculture system that degrades mariculture fish waste. Newly identified strain F2b, presumed to be of the genus *Dethiosulfovibrio*, is of particular interest for such projects. It represents a smaller part of a five-member consortium of microorganisms, including methanogens and fermenters, which degrades such waste into biomethane in a two-step process. To this end, ideal growth conditions of the fermentative strain F2b were determined. Growth curve experiments were conducted to test tolerances to temperature, pH, and salinity for this strain; growth in the presence of various substrates was measured as well. It was shown that this species displays optimum growth under typical marine conditions of 30^{o}C, pH 7.0, and 0.2 M NaCl (some tolerance for changes to these conditions was observed). Additionally, growth was only observed on proteinaceous substrates and some amino acids. These results have important implications for the future culturing of halotolerant anaerobic organisms to fulfill aquaculture-related needs on an industrial scale, since recirculating systems would have to be designed with the tolerances of the microbes in mind. If this can be achieved, the consortium being studied would demonstrate over 90% efficiency in digesting mass quantities of fish waste and producing useful fuel, rather than waste, as an end product.

Junior Research Abstracts

Drug Resistance in B Raf Mutated Melanoma cells

Anisa Hofert

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

Cancer develops when a cell mutates and is not able to control or stop proliferation, which is controlled by signal transduction pathways, which use protein chains to create an outcome in the cell. The pathway that controls proliferation in melanoma cells begins with the RAS protein followed by the expression of RAF, MEK, and ERK proteins. Melanoma cell types with B Raf mutations are being studied to understand their resistance to drugs that inhibit different steps in the proliferation pathway. The B Raf mutation stops the negative feedback reaction that would ordinarily suppress the production of new cells. Because resistance to MEK and RAS inhibitors has been confirmed, ERK inhibitors are now being tested to determine if they could be an effective treatment to stop the cancer. Western blots were used to determine the production of tubulin, actin, and important proteins in the pathway such as MEK. It was observed that proliferation proteins were generally more abundant in the resistant cells than the parent cells that had been treated with the drug for only a short \time. The tubulin levels had greatly increased which indicates the growth in size of the cell. To confirm this, images of the tubulin were captured using fluorescence microscopy. These showed a great increase in size for the resistant cells, which indicates that they are thriving and that resistance was developed. This suggests that the cancer cells will adapt to the drugs and the treatments will become ineffective. The evidence shows that ERK inhibitor treatments alone can only be used as a short term treatment and will eventually lead to the development of a stronger, more virulent tumor.

Visualizing Cell Signaling through Development of a FRET Biosensor

Yoav Kargon

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

Aurora Kinase 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 cells. To study the role of Aurora Kinase A in mammalian cells, a biosensor 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 will be based on an intramolecular FRET sensor template reported to facilitate creation and optimization of such biosensors. Aurora A activity in cells expressing the sensor will cause the two fluorophores in the sensor to come together, producing a measurable FRET signal. The creation of the Aurora Kinase A sensor will allow further research into the enzyme's role in the cell by allowing real-time visualization through time-lapse fluorescent microscopy of the enzyme acting in living cells.

Junior Research Abstracts

The overexpression in IDH1 in Triple Negative Breast Cancer (TNBC) Cells when treated with CB839 and the connection with Glutamine dependency

Jasmine Long

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

Metabolic alterations have recently emerged as one of the hallmarks of cancer. Cancer cells replicate more rapidly, causing higher biosynthetic and bioenergetic demands. Glutamine serves as an important source of energy and building blocks for many tumor cells. The first step in glutamine utilization is its conversion to glutamate by the mitochondrial enzyme glutaminase. CB-839 is a potent, selective, and orally bioavailable inhibitor of both splice variants of glutaminase (KGA and GAC). After treatment with the drug CB-839, real-time PCR was used to analyze gene expression, and this showed a common over expression of the gene IDH1 in TNBC cell lines. TNBC cell lines were previously shown to be glutamine dependent. IDH1 is a gene that has been found to play a role in cell metabolism and cancer cells when mutated, therefore there may be a link between glutamine dependency and IDH1 over-express in TNBC cells. Determining if there is a link between IDH1 and glutamine dependency in TNBC cells could influence further research in TNBC specifically and allow for more effective treatment, either post initial treatment with CB-839 or an entirely different treatment plan.

The Effects of Climate Change on Zebrafish Mobility and Reproduction

Julianna Lucas

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

Climate change has been occurring since the beginning of time, but with rapid climate change, most organisms are unable to adapt to their ever-changing habitats. Zebrafish are commonly used as model vertebrate organisms for a variety of reasons and I chose to use them because their life cycles are accelerated. My research goal is to test a variety of environmental factors on zebrafish and assess how they affect the fish by means of the endocrine system. At the larval stage, the fish will be raised in varying conditions of temperature and salinity. They will then be monitored and tested for movement and mobility while still in the larval stage. Some of the fish will also be raised to adulthood to test the effects of the environmental factors on reproduction. The overall purpose of this research is to identify how climate change might affect fish in the coming years, so that the effects can be more efficiently and effectively addressed.

Junior Research Abstracts

Characterizing Motion and Orientation Perception in mustela putorius furo

Samantha Niziolek

Mentor: Kristina Nielsen Ph.D
Institution: Department of Neuroscience, Johns Hopkins Mind/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 every day, with specialized components, each individually taking into account color, texture, form, orientation, depth and motion. Motion perception is processed by the V4, and orientation by the V5. We can quantify both motion perception and ability to perceive orientation 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 on the same subject. By comparing behavioral studies with physiological data we can better understand the function of these specialized components, which will help improve understanding of developmental disorders, and unique disabilities such as akinetopsia, ultimately helping with treatment. Gathering data from different parts of the brain as it responds to various stimuli allows us to piece together how specialized neurons in areas of the visuals system relate and coordinate signals to form a cohesive visual reality.

Sports Teams' Impacts on Their Communities

Sydney Rosebrough

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

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. Previously published studies have used data analytics to demonstrate connections between sports events and other aspects of the community, such as the impact of game days on crime rates, the effect of social media on sports events, and ticket prices on the performance of a team. My current work focuses on four cities: Baltimore, Pittsburgh, Cleveland, and Cincinnati. These four cities all have football teams in the National Football League (NFL) and all are members of the AFC North division. Each also each has a baseball team that is a part of the Major League Baseball (MLB) organization. I use data provided by the NFL, MLB, and other public sources to conduct analyses. Thus far, I have looked for the correlations between the overall performance scores (PCT), ticket prices, and the cost of living in each city. My goal is to continue to conduct more analyses and further study these relationships.

Junior Research Abstracts

Opportunistic bacteria in the gut microbiomes of pediatric IBD patients

Aishwarya Shettigar

Mentor: Dr. Cynthia L. Sears
Institution: Johns Hopkins University School of Medicine, Division of Infectious Diseases

The onset of many serious digestive diseases, namely inflammatory bowel disease (IBD) and colorectal cancers (CRCs), has increasingly been linked to bacterial infections in the gut microbiome. Three strains of intestinal bacteria, enterotoxigenic *Bacteroides fragilis*, colibactin-producing *Escherichia coli*, and *Fusobacterium nucleatum*, have been identified as virulent., and hypothesized to have some negative effect on intestinal environment, and thus some effect on the progression of inflammation-based conditions. However, the degree to which these bacteria play a role, and the specific mechanisms they use, is largely unknown. Previous studies on diseases of the lower digestive system have made effective use of stool analysis. Stool samples were obtained from a population of IBD children, along with a control cohort of healthy children, and analyzed through a combination of genetic and microbiological approaches. The first approach is qualitative and involves direct 16s rRNA PCR analysis of bacterial isolates from stool cultures. Another approach is analysis through real-time quantitative PCR (qPCR) to detect and quantify the populations of virulent strains relative to their commensal counterparts. The purpose of these methods is to study the prevalence of one or more organisms of interest in the pediatric population. The results of these experiments provide a foundation for future research on the mechanisms of virulent bacteria in the gut.

The Effect of Angiotensin On Arginase and Its Potential Applications for Vascular Health

Jacob Smith

Mentor: Dr. Lewis Romer
Institution: Johns Hopkins University School of Medicine Department of Anesthesiology and Critical Care Medicine

The endothelial system is an ever-changing and important part of the vasculature, with a variety of functions including the regulation of the constriction and relaxation of the smooth muscles that compose the vascular system. Endothelial dysfunction is a factor in diseases such as atherosclerosis and pulmonary hypertension, resulting in decreased production of the vasodilator nitric oxide, which in turn leads to decreased blood flow. It has been shown that angiotensin, a peptide hormone, increases arginase I production in rat aortic smooth muscle cells, and that expression of the protein arginase II leads to endothelial dysfunction by resulting in a decreased levels of nitric oxide being synthesized. To learn if angiotensin is a regulator of arginase II in the endothelial system, the immunoblotting technique was performed with human aortic endothelial cells dosed with varying concentrations of angiotensin. Preliminary results show that angiotensin may result in the decreased production of arginase II, but more trials need to be conducted. If a link is found between angiotensin and arginase in human aortic endothelial cells, it could potentially be targeted in treatments for diseases involving damaged vascular health.

Junior Research Abstracts

Determining Optimal Dose Response for Tyrosine Kinase Inhibitors

Samuel Smith

Mentor: Dr. Mark Levis MD
Institution: Johns Hopkins Medicine Department of Oncology

Acute myeloid leukemia is a cancer of the blood characterized by the overproduction of premature cells, and by consequence underproduction of mature cells. Flt3 is a very prominent protein in AML cases, with mutant Flt3 present in approximately 30% of AML patients. This, combined with the fact that Flt3 belongs to a very small closely related group of proteins, has made Flt3 a common target for the development of tyrosine kinase inhibitors, drugs developed to target a specific protein. After the approval of such drugs, there are a few factors that must be taken into account to determine appropriate dosage levels. The two most important factors are potency and toxicity, meaning how good a drug is at killing cancer cells and how good it is at not killing healthy cells. The balance between these two factors is very important when choosing the optimal dosage level. Before advancing to clinical trials, the potency of a drug at different concentrations is determined by dose response and MTT assays. Both of these methods center around incubating a cancer cell line in different concentrations of drug, then testing how effective the drug is, the first by percentage of protein inhibited and the second by amount of living cells. Toxicity of a drug can be measured, in part, through dose response assay, but is mainly figured out through clinical trials. Clinical trials also offer more accurate data on potency of a drug.

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

Sydney Worsham

Mentors: Dr. Henry Brem, Betty Tyler, Dr. Antonella Mangraviti
Institution: Johns Hopkins Medicine Department of Neurosurgery

PNS (Peripheral Nervous System) nerves are able to spontaneously regenerate following injury, however successful regeneration depends on several different factors. At the site of the lesion, a message gets sent to the neuron informing it of injury, to which it can respond in one of two ways: apoptosis (programmed cell death) or regeneration. Until now, there have been no other studies evaluating ongoing, in-vivo regeneration of axons following peripheral nerve grafting using diffusion tensor imaging (DTI). Our work five groups' DTI scans with their histological samples over time to determine whether it is possible to visualize a nerve regenerating through a commercially available nerve graft (Avance, Axogen Inc.) at various states of re-growth. Our hypothesis is that Diffusion Tensor Imaging (DTI) will provide discernible visualization of nerve regeneration through a commercially available nerve allograft for clinical use. Preliminary results from histological analysis show a successful regeneration of the sciatic nerve both trough the allograft and in the distal nerve to the graft. The correlation of the histological results with the DTI measurements is in progress. 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 quantitative method to evaluate peripheral nerve degeneration and regeneration. Using the DTI technique as a continuous, non-invasive evaluation of progress and complications following nerve grafting would improve specificity in detecting microstructural changes in degenerating and regenerating nerve fibers.

Junior Research Abstracts

Fabrication of Microgrippers for Use in Single-Cell Analysis

Amy Zhang

Mentors: Dr. David Gracias, Qianru Jin
Institution: JHU Department of Chemical and Biomolecular Engineering

A new method of relatively inexpensive, high-throughput, and active single-cell analysis is developed with the fabrication of single-cell microgrippers using multilayer photolithography and use of Raman spectroscopy. Constructed on a quartz wafer, the grippers are composed of three main layers: the copper sacrificial layer, the SiO/SiO_2 stress bilayer, and lastly, the SiO_2 rigid segment layer, each with a unique mask pattern. The finished gripper can be actuated with ammonium persulfate, which will dissolve the copper sacrificial layer and cause the bilayer arms of the gripper to fold around any specific kind of cell. The rigid segments prevent the arms from collapsing upon themselves. The enclosed cell can then be analyzed with Raman spectroscopy over a period of time to reveal details about its elemental composition, bond types, and molecular structure for the purpose of identification. Two additional aspects of this project were developed as steps toward potential *in vivo* applications: 1) exploration of live cell capture, which used a germanium sacrificial layer; and 2) magnetic mobility, which used additional iron and wax layers. The microgrippers allow for analysis on a single-cell scale, effectively allowing for the study of individual components of a heterogeneous group of cells. This is useful in understanding diseases that may vary from person to person and in creating personalized medicinal treatments.

Sophomore Research Interests

The sophomores have completed the initial phase of the Ingenuity Research Program. During the first semester of 10th grade, they identified topics of interest, researched current information about their selected topics, and began searching for 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 describe their research interests to a public audience.

From Left: Moufidatou Adedoyin, Mikell Myers, Alida Schott, Sophia Hager, Bennett Persons, Alex Li, Mercedes Thompson, Sherry Bossard, Azeem Lyons, Sydney Junker, Iven Chen-Van Dyk, Nick Good, Robert Henry, Elijah Dukes, Robert Blanchard, Rebecca Brody, Duncan Parke, Caterina (ShinShin) Erdas

Not pictured: Claire Wayner and Ezra Szanton

Sophomore Interest Statements

The Fight against HIV/AIDS

Moufidatou Adedoyin

The human immunodeficiency virus (HIV) is an infection that damages the body's immune system. The virus has the potential to lead to AIDS, the acquired immune deficiency syndrome. Approximately 34 million people worldwide suffer from the virus. Millions of lives have been claimed by AIDS and people are continually being newly infected. In the United States, Black people make up a lower percentage of the population, about 13%, but they make up 46% of new HIV infections. Methods of transmission include sexual contact, the sharing of needles, pregnancy, and other forms of sharing infected bodily fluids. The current treatment of HIV/AIDS is mainly antiretroviral therapy, which consists of taking a combination of antiretroviral drugs. Recently, new methods of treatment have been developed, including HIV vaccines. Scientists have found a way to deliver experimental HIV vaccines that seems to be relatively safe, and which stimulates an immune response to the virus. The ability for this method to provide a long-term immune response is questionable, as many clinical trials on experimental vaccines have shown only short-term benefits for patients. As research in this field progresses, many lives may be impacted globally. Better treatments and more effective vaccines could benefit places such as Nigeria, where the HIV virus has led to higher mortality rates and a significant population decrease.

Tissue Engineering and Bio-Artificial Organs

Robert Blanchard

Tissue engineering is a combination of engineering, cell biology, and material science with the purpose of improving biological materials and functions. Engineered tissue is grown in a scaffold. One major application of tissue engineering is the development of mini organs that can model a real organ. These mini organs are grown from some kind of stem cell and are used to test drugs in order to determine how effective the drugs on human cells, instead of cells from lab animals. Another main application of tissue engineering is the creation of transplantable organs. In the U.S. about 8,000 people die annually due to lack of organ transplants. These deaths could be prevented with the growth of artificial organs or the building of organ-like devices.

Genetics and Human Traits

Sherry Bossard

Behavioral genetics and genetic epidemiology are fields of genetics that focus on determining the heredity of personality and personality disorders. According to recent research, all psychological traits are heritable and observable in all species; the genetic influence is in the range of 40% to 50%. Concerning social attitude (in humans), the genetic effects are there, they just don't appear until after age 19. From the results of another recent study, scientists now postulate that the genetic factors involved with risky behaviors could help predict a person's reaction to certain medications. Knowing the genetic influence on personality could not only help predict a person's response to a certain type of medication but could also help develop new medications. Scientists would know which specific genes in the body affect that trait and could target medication directly to that gene. In the future scientists could also find ways to correct personality disorders very early in a child's life while cerebral systems are still developing and changing and, even further, prevent personality disorders altogether.

Sophomore Interest Statements

Commonalities Among Autoimmune Diseases

Rebecca Brody

Autoimmune diseases are a family of disorders resulting from a malfunction of the immune system, in which immune cells attack normal body tissue. There are more than 80 identified autoimmune diseases, each with distinct symptoms. As a group, these diseases affect around 23.5 million Americans, often resulting in a decreased quality of life for these individuals. Unfortunately, the causes of these diseases are still largely unknown, meaning there are few effective treatments or cures. One way researchers are currently trying to gain a better understanding of autoimmune diseases is through examination of common factors among the diseases. These factors mainly involve the interactions between genetics and the environment in the development and severity of autoimmune disease. Some genes and environmental factors have a confirmed connection with autoimmunity, but there are still many yet to be discovered. During junior year, I will be working with Dr. Sharon Gerecht of the JHU Dept. of Chemical and Biomolecular Engineering. Dr. Gerecht's lab combines the study of stem cells and the engineering of extracellular matrices to grow blood vessels in vitro. These blood vessels can be used for a study of a wide range of diseases that affect the blood vessels of humans. I will be working with the part of the lab that focuses on stem cells; more specifically, I will be investigating the most efficient methods of stem cell differentiation to create healthy blood vessels.

Invasive Neural Implant Design and Function

Iven Chen-Van Dyk

Neuroprosthetics is a highly intersectional field that represents the next generation of prosthetics. Neuroprosthetic limbs can be controlled through thought, while neuroprosthetic sensory replacements are able to replace or supplement damaged senses. The success of neuroprosthetics depends on many factors, but the neural and myoelectric interfaces are important design aspects. Longevity and biocompatibility are high on the list of priorities for these interfaces. Currently, my goal is to participate in research with Dr. Nitish Thakor, head of the JHU Neuroengineering and Bioinstrumentation Lab. Most recently, in January of 2016, he published a review article on implantable neurotechnologies and the current trends of the field.

Understanding the Zika Virus

Elijah Dukes

Discovered 69 years ago, the Zika virus previously had received little attention in terms of research and understanding. However, several outbreaks have occurred in the last nine years, beginning with Yap Island in 2007, and including an epidemic in Brazil in the spring of 2015, contributing to renewed interest in the virus. Zika symptoms for most people affected are joint pain, red eyes, fever, rash, but they can also be asymptomatic. A major concern is the effect on the developing brain of a fetus, which is associated with microcephaly. A high number of Zika virus copies were found in the fetal brain of an aborted microcephalic fetus. Other studies show that Zika may be more than just an infant cell attacker. During the recent Zika outbreak in French Polynesia, there was a large increase in people who were admitted to the hospital with Guillain-Barré syndrome, where nerves are attacked by the immune system. A large percentage of the people diagnosed with GBS reported Zika-like symptoms about six days before the onset of neurological problems. These associations increase the importance of further studies on the disease.

Sophomore Interest Statements

Parasite Microbiology and Immunology

Shin Shin Erdas

I researched different parasites' methods to invade, thrive and sometimes control their hosts at the molecular level, and how hosts react and fight the parasites. I became really interested in the human parasite Brugia malayi, which causes swelling of the lower limbs and predominantly afflicts third world countries where proper medical attention is hard to access. Nearly all filarial nematodes (a type of parasitic worm), including B. malayi, heavily rely on their bacterial endosymbionts belonging to the genus Wolbachia. Genetic sequencing of B. malayi and Wolbachia has been used to analyze the parasitic relationship between the two species and the human host. Some scientists hypothesize that the method this parasite uses to evade the immune system could be applied to autoimmune disease research. I plan to work under Dr. Alan Scott, a researcher at the Department of Molecular Microbiology and Immunology at Johns Hopkins School of Public Health. His lab works on identifying the proteins, specific immunological-related gene expression, and life cycle stages in filarial nematodes and other parasitic worms. I will be studying a species of hookworm – a microscopic, translucent, and parasitic worm that lives in the soil. Typical symptoms of infected individuals include stunted growth and slow cognition.

Snake Venom: The Competition for Receptors

Nick Good

Herpetology and toxicology focus on characteristics of animal toxins; a large portion of which are from snakes, and how those toxins affect the victims of snake bites. It may seem like each toxin has a specific target (since each one has a unique effect on the body), but they actually share a common feature: the targeting of receptors. Virtually every snake toxin serves its purpose by attaching to various receptors in the body, which poses a problem because that prevents cells of the body from attaching to those very same receptors. A researcher at Johns Hopkins University, Dr. Frank Bosmans, is studying the NAV channels in the body, which are affected by both animal toxins and drugs. He aided a research project that successfully identified the first snake toxin to bind to GAB(A) receptors, which are pores on nerve cells in the brain and spinal cord. These receptors filter negatively charged ions out of cells, so that their equilibrium can be reset in order to send out messages. This fascinates me because it shows a connection between how most snake venoms interact with the human body.

Neuroscience in Relation to Addiction and Mental Illness

Sophia Hager

Behavioral neuroscience is the study of how the biology of the brain affects behavior. Addiction and mental illness are both good examples of subjects that can benefit from being researched in the context of neuroscience. This could lead to better treatments for people suffering from these diseases, due to the fact that the structure of the brain is different from the norm in both addicts and people struggling with mental illness. I am currently searching for a mentor, and have talked to several people about possibly working in their labs. So far, none have accepted, but I intend to continue trying until I find a mentor, who hopefully will be willing to work with me on addiction.

Sophomore Interest Statements

Material Science

Robert Henry

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 include: biomaterials, nanomaterials, ceramics, metals, plastics (polymers), and electrical, optical, and magnetic materials. Scientists are currently working to learn about amorphous metals, a new materials category. Recently, it was discovered that an amorphous metal can contain a magnetic field. Scientists 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 exploring space, cars will become more efficient and release less pollutants, and injuries will be healed more easily.

Etiology of Suicidal Behavior

Sydney Junker

Suicide is one of the leading causes of death around the world today. Studies have found that there are multiple factors affecting the nervous system that lead to suicidal thoughts/ideas, such as multiple genes, neurotropic pathogens, and the hypothalamic-pituitary-adrenal (HPA) axis' role in stress. Various blood tests and algorithms are currently being used to identify at-risk individuals, but treatments have yet to be created. So far, I have found two people with whom I would like to work, but my primary mentor candidate is Dr. Holly C. Wilcox at the Johns Hopkins Bloomberg School of Public Health. She works in the Mental Health Department and studies the physiological etiology of suicidal behavior in minors, as well as the HPA axis, which is what I would primarily like to study.

The Effects of Heavy Metals in Human Health

Alexander Li

People use and are exposed to heavy metals (lead, mercury, cadmium, etc.) every day. Some may be exposed to these metals more than others, and may experience their side-effects. Heavy metal poisoning can be harmful or even fatal. Scientists are still studying what effects these metals have on humans, and how heavy metal poisoning can be treated or prevented. One mentor candidate I am considering is Ellen Silbergeld, who is a professor at Johns Hopkins Bloomberg School of Public Health. She studies lead and mercury poisoning, and has done research on how lead affects the central nervous system. Another mentor candidate I'm considering is Joseph Bressler, who also works at Johns Hopkins School of Public Health. His current research involves the blood-brain barrier and how transporters mediate the uptake of heavy metals.

Insect-Controlling Entomopathogenic Fungi

Azeem Lyons

Ophiocordyceps unilateralis is an entomopathogenic fungal obligate parasite, which is a fungus that relies on infecting insect hosts to live and reproduce. It is unique in the sense that it can control the bodies of hosts, hijacking their central nervous systems with chemical cocktails. Different species of Ophiocordyceps prefer different species of hosts, only being able to control the bodies of the hosts that suit them. These hosts often have very subtle genetic differences, yet the fungus is able to discern which species to control and which to simply kill. Beyond this, the ability to input precise commands into varying host species interests me. While I do not currently have a mentor, I would like to work in the field of mycology - the study of fungi - in order to investigate the Ophiocordyceps fungus' unique properties. Possible mentor candidates include the USDA Systematic Mycology and Microbiology Lab in Maryland and other mycology labs.

Sophomore Interest Statements

Applications of Brain Computer Interfaces to Flight

Mikell Myers

Brain computer interfaces and flight, my two main research interests, are quite similar. While researching more about both topics, I have learned that BCIs have more applications in space and other fields than I had previously expected. This has slightly altered my interests; I want to be able to apply the BCI technology to applications not yet studied on a broad scale, most notably flight. In my efforts to learn more about this field, I looked at the research of Dr. Nitish Thakor, who works in the JHU Neuro-engineering and Biomedical Instrumentation Lab and who focuses on BCI technology. For my future work, I will join Dr. Amy Bastian at the Kennedy Krieger Institute. Dr. Bastian uses movement tracking technology and non-invasive brain stimulation to help people with neurological damage.

Plant Evolution and Climate

Alida Schott

Fossils are most often associated with animal remains, but this image is not entirely correct—plant fossils offer valuable information about prehistory, too, and they provide information that's still relevant today. The study of plant fossils, or paleobotany, examines past algal, fungal, and plant life and prehistoric environments. Paleobotany's two main applications are climatology and evolution. Knowledge of prehistoric plants allows researchers to figure out Earth's climate millions of years ago, to classify both modern and extinct plants taxonomically, to infer how prehistoric continents were arranged, and to determine how the first plants arose. By applying discoveries about plant evolution to climatology, we can learn how plants have been affected by previous fluctuations between "greenhouse" periods and "ice ages" of Earth's climate. Paleobotany and especially climatology will become increasingly important analytics as climate change's effect on the Earth becomes an increasingly significant issue.

Emergent Intelligence in Modular Robotics

Ezra Szanton

Modular robotics is an innovative branch of robotics that looks to use multiple smaller robots to accomplish the tasks of a larger one. One of the main goals of the field is to create self-reconfigurable robots that would be able to rearrange themselves to accomplish such tasks. A top-down approach makes this difficult because the controller would have to know how to react to each situation. Observations of a robot's surroundings offer a bottom-up approach based on the interactions between individual modules. Simple rules govern each module, but together they exhibit a larger intellect. This phenomenon is called emergent intelligence, and can be applied to modular robots to make them self-reconfigurable. I am currently searching for mentor candidates, and these include Dr. Gregory Chirikjian. He directs the Robot and Protein Kinematics Lab at Johns Hopkins and studies self-reconfigurable robots and self-replicating robotic systems.

Sophomore Interest Statements

Transhumanism: Brain Computer Interface and Prosthesis

Duncan Parke

With our own medicine, tools, beliefs, and infrastructure, we have extended life and the ability to reproduce to those in seemingly unlivable conditions. Since there are limits to how we evolve naturally, we must instead look to our own ingenuity to reach the next stage of human evolution. Many avenues of research, including prenatal genetic modification, pharmaceutical enhancement, transcendence, and robotics, have opened exciting new opportunities for the merge of Biology and other hard sciences into quasi-evolutionary period for mankind. We can now outlive our ancestors by years, often times staying active until the end, but in embracing transhumanism, we can exceed their physical and mental capacities as well. Robotics allows us to go above and beyond in physical capacity, and for now is the field of transhumanism showing the most promise. Exoskeltons, or powered mechanical suits, are currently being developed for industry and military use. These machines allow users to achieve previously unattainable physical work capacity, including increased movement speed, increased jump height, increased carrying capacity, and increased agility. But in looking at what makes us superior, besides our own intellect, to animals such as the wolf or tiger, are our opposable thumbs. Our hands are how we create and how we innovate. They allow us to manipulate our environment, hold tools, and even save lives. This is why I have chosen to look into the field of advanced robotic prosthetics for further research. Great projects, such as the Modular Prosthetic Limb at the APL or other research at Brown University have been yielding promising results in limb replacement and enhancement. With 17 points of actuation, once an effective control mechanism, these machines may become more precise than our own hands, and a replacement for individuals everywhere, especially with the dawning age of wearable technology just beginning to unfold.

Neuroanatomy of Bipolar Disorder

Bennett Persons

Bipolar disorder has proven to be something of an elusive topic with respect to the physiological mechanisms of the disorder's symptoms, complicating the investigation of effective treatments. Without proper physiological knowledge of the bipolar brain, we are effectively left in the dark when it comes to efficient, direct diagnosis, and are leaving the job of diagnosing potentially affected individuals to the possibly erroneous process of multiple psychological meetings and tests, all of which are highly subjective on a person-to-person basis. In conducting my research, I hope to gain a greater understanding of my topic of the neurological basis of bipolar disorder and its treatment, and maybe even develop a method for creating a telltale test for the disorder and/or a method for testing the effectiveness of mood stabilizers, specifically lithium. I've also identified two researchers whose work is well-suited to my interests: Dr. Francis Mondimore at the Johns Hopkins Bayview Medical Center, who has worked in the fields of bipolar disorder and neurophysiology; and Dr. Holly Wilcox at Johns Hopkins University, who has dealt with bipolar disorder and suicidality.

Sophomore Interest Statements

Regenerative Medicine

Mercedes Thompson

Regenerative medicine is the study of the various ways in which tissues/organs can be grown for transplantation. Currently, the most clearly identified methods of regenerative medicine are the growth of organs in petri dishes, the printing of organs using 3D printers and cells, and xenotransplantation - the genetic modification of animal organs for transplantation into humans. I currently am in contact with Dr. Agnes Azimzadeh, who is studying xenotransplantation at University of Maryland, and will be my mentor this coming summer and into junior year. University of Maryland is one of the few labs across the nation studying this exciting and revolutionary research, which I look forward to being a part of.

Avian Neurology

Claire Wayner

A recent influx of study in avian neurology has allowed neurologists to answer broader questions about brains in general and how the human brain functions. I am particularly interested in using bird brains as a model to propose solutions to human diseases. Birds are able to grow new neurons to replace old, damaged neurons through a hormone-induced process called neurogenesis. Neurogenesis is performed in limited quantities in mammalian brains, but it could possibly be induced in damaged areas of a human brain to cause brain repair. This could have large implications for curing neurodegenerative diseases. Birds are also extremely similar to humans in how they learn complex speech patterns. By studying avian neural circuits, researchers could formulate solutions to human speech disorders and deficits. Current research in Baltimore, however, focuses on using the bird brain to investigate animal behavior like spatial perception and reasoning. For example, Dr. Shreesh Mysore at Johns Hopkins University studies birds to understand larger concepts about animal neurology and learning capacities. Studying animal behavior, however, is not what fascinates me most, and the lack of research in the Baltimore area on bird brains and human neurological disorders has led me to consider other topics. Most recently, I am considering the topic of environmental engineering and the use of a combination of environmental chemistry, microbiology, and engineering to solve world problems dealing with wastewater and aquatic chemical pollution. For junior practicum, I will be working with Dr. Sarah Preheim, at the JHU Department of Geography and Environmental Engineering, who is researching microbial ecology and the management of microbes in our water systems.

Class of 2016 : College Acceptances

Nana-Ama Acquah
Florida State University
Louisiana State University
University of Maryland, College Park
North Carolina A&T State University
Pennsylvania State University – All Campuses (undecided)

Assefa Akinwole
Howard University
Morehouse College
Pennsylvania State University – All Campuses
Rochester Institute of Technology
UMBC (Meyerhoff Scholar)*

Sydney Anselme
Frostburg State University
Goucher College
McDaniel College*
St. Mary's College of Maryland
St. John's College
UMBC

Simon Benzer
UMBC
University of MD, College Park
University of South Carolina*
Towson University

Cullen Bray
Christopher Newport University
UMBC*
Virginia Commonwealth University
College of William and Mary

Shoshana Brody
Emory University
University of Maryland, College Park (College of Agriculture & Natural Resources)
Pennsylvania State University – All Campuses (College of Ag. Sciences)
Pennsylvania State University, Schreyer Honors College*
University of Vermont (College of Agriculture & Life Sciences)
University of Virginia (College of Arts & Sciences)

Marissa Bush
McDaniel College
Morgan State University*
UMBC
University of Maryland, College Park

Imani Dews
Clark Atlanta University
Hampton University
Howard University
Morgan State University*
Spelman College
Temple University

Aaron Fink
The Cooper Union for the Advancement of Science & Art*
University of Maryland, College Park

Benjamin Garlow
Johns Hopkins University*

UMBC = University of Maryland, Baltimore County

Class of 2016 : College Acceptances

Rebecca Gearhart
Fordham University - Lincoln Center Campus/ Rose Hill Campus
University of Maryland, College Park
University of Pennsylvania*
University of Richmond
University of Virginia

Jessyka Grell
Bucknell University*
Temple University
Towson University
UMBC
University of Maryland, College Park

Andrew Grier
University of Delaware
Dickinson College
Gettysburg College
St. Mary's College of Maryland
Washington College*

Benjamin Grove
University of Maryland, College Park (Scholars)*

Thomas Heck
University of California, Los Angeles
University of California, San Diego
Hawaii Pacific University
University of Maryland, College Park*
University of Vermont
Washington University in St. Louis

Alexander Hilger
Drexel University
UMBC
University of Maryland, College Park*

Harry Huntley
Cornell University
Deep Springs College
Johns Hopkins University
University of Maryland, College Park (Banneker-Key Scholar)*
The Ohio State University
University of Vermont
Warren Wilson College

Ana Islas
Bucknell University*
Hofstra University
UMBC
Stevenson University
Towson University

Katheryn Jennings
University of Maryland, College Park (Banneker-Key Scholar)*
McDaniel College

Kathy Le
Johns Hopkins University*

Cresangelo Legaspi
Johns Hopkins University*

Si Lin
Johns Hopkins University*
Loyola University of MD
UMBC

Omar Lloyd
Johns Hopkins University*

Class of 2016 : College Acceptances

Jacob Lohr
Towson University*

Kyle Low
UMBC
University of Maryland, College Park
University of Virginia
Lafayette College*

Jakob Lucas
Bucknell University
UMBC (Honors College and a Sondheim Public Policy Scholar)*
North Carolina State University
Purdue University

Devry Mason
Hampden-Sydney College
Lynchburg College*

Yitzhak Oshry
Drexel University
UMBC (President's Scholar)*
University of Maryland, College Park

Ema Pagliaroli
Hofstra University
Fordham University
University of Maryland, College Park*
Seton Hall University
Towson University
St. Mary's College of Maryland

William Povell
Boston University (College of Arts and Sciences)
Brown University (School of Engineering)*
University of Chicago
University of Maryland, College Park (Honors Program)
University of Pittsburgh (University Honors College)
Reed College
University of Rochester

Troi Ratchford
Clarkson University
Florid A&M University
Howard University
Lincoln University
Morgan State University*
Salisbury University
Spelman College
Susquehanna University

Luc Renaux
Johns Hopkins University*

Lauren Roundtree
Northeastern University
Rutgers University-New Brunswick
University of Maryland, College Park*

Henry Sin
UMBC*

Class of 2016 : College Acceptances

Samuel Stahler
UMBC
University of Maryland, College Park*
Pace University, New York City
Towson University

Jonathan Stonely
Brigham Young University*

John Dave Tinawin
UMBC
Stevenson University
Towson University
University of Maryland, College Park*

Tionna Wells
Delaware State University
University of Delaware
Howard University
University of Maryland, College Park*
Susquehanna University
Temple University
William Paterson University of New Jersey

Faith Wilkins
Cornell University (College of Ag. & Life Sciences)
Hampton University
University of Maryland, College Park*
(Banneker-Key Scholar)
St. Mary's College of Maryland
Virginia Institute of Technology

Humza Yaqoob
Towson University*

Max Yuhas
University of California, Los Angeles
University of California, San Diego
University of Maryland, College Park
(Honors Program, Banneker-Key Scholar)
Yale University*

Student Awards and Honors

The Intel Science Talent Search

Kathy Le, was selected as a national semifinalist in the 2016 Intel Science Talent Search, for her project "Activating mutations in FGFR leads to a competitive advantage in Drosophila germline stem cells." Kathy did her work at the Johns Hopkins School of Medicine Department of Cell Biology and was mentored by Dr. Erika Matunis and Leah Greenspan.

The Baltimore Science Fair

Fifteen Ingenuity students presented projects at the 2016 Baltimore Science Fair held at Towson University. Senior Alex Hilger won the 1st place award in the physical sciences category for his work to develop a drone-based LIDAR system. Alex went to Phoenix, AZ in May to compete at the 2016 Intel International Science and Engineering Fair (ISEF).

1st Prize, Physical Science

Alex Hilger, *"Drones Equipped with LiDAR for 3D Mapping"*

Honorable Mention, Biological Science

Aishwarya Shettigar, *"Opportunistic bacteria in the gut microbiomes of pediatric IBD patients"*

Honorable Mention, Physical Science

Robin Graham-Hayes, *"Construction of an Autonomous Adaptive Robot"*

Andrew Frock, *"Photoelectron Spectrometry with an Electrospray Ion Source"*

Amy Zhang, *"Fabrication of Microgrippers for Use in Single-Cell Analysis"*

Special Awards

AIAA- Honorable Mention, Robin Graham-Hayes; 1st place, Alex Hilger

American Society for Quality- 1st place, Simon Benzer

Association for Computational Machinery- Will Povell

ASM Materials Education Foundation- Cresangelo Legaspi

ASU Walton Sustainability Award- Luc Renaux

Intel Excellence in Computer Science- Will Povell

International Council on System Engineering- Honorable Mention, Will Povell; 1st place, Alex Hilger

Mu Alpha Theta- Will Povell

National Institute on Drug Abuse- 1st place, Lauren Roundtree

National Organization of Gay & Lesbian Scientist & Technical Professionals- 3rd- Nick Eusman, 2nd Rebecca Gearhart, 1st Amy Zhang

National Security Agency- Alex Hilger, Will Povell

National Society of Black Engineers- Cresangelo Legaspi, Alex Hilger, Faith Wilkins

National Space Society- Emma Eklund, Robin Graham-Hayes, Alex Hilger

Raytheon Solypsis- 2nd place ($500) Will Povell

Society for In-Vitro Biology- Anisa Hofert

US Air Force- Emma Eklund, Robin Graham-Hayes Alex Hilger,

US Army- Rebecca Gearhart, Kathy Le, Luc Renaux, Eterick Stonley

US Navy- Alex Hilger

Student Awards and Honors

MD Junior Science & Humanities Symposium

Amy Zhang—2nd Place, Kathy Le – 3rd Place

Amy and Kathy earned the opportunity to compete at the 53rd National Junior Science & Humanities Symposium in Dayton, OH on April 27-29, 2016.

Mathematics Competitions 2015-2016: Best Problem Solvers

University of Maryland College Park High School Mathematics Competition

Aaron Fink was the school winner, invited to Part II of the competition.

Yitzhak Oshry, Andrew Frock & Yoav Kargon also recognized.

AMC- 10-12

Yitzak Oshry and Max Yuhas are the AMC-12 school winners; Aaron Fink was a team member who also received recognition. Robert Blanchard was the AMC-10 school winner;

Duncan Parke and Claire Wayner also received recognition.

Maryland Math League

The best solvers were Andrew Frock, Max Yuhas, William Povell, Harry Huntley & Yoav Kargon.

Future Scholars Program

Lauren Fink, Andrew Frock, Stephen Grabowski were accepted into the Future Scholars program at the Johns Hopkins University Department of Mathematics and will take college math courses there next year.

Jack Kent Cooke Scholarship

Ingenuity senior Kathy Le is a recipient of this prestigious award.

2016 Baltimore Scholars

Six Ingenuity seniors received four-year, full-tuition scholarships to the Johns Hopkins University:

Ben Garlow
Kathy Le
Cresangelo Legaspi
Si Lin
Omar Lloyd
Luc Renaux

Student Awards and Honors

800 SAT and **SAT 2 Scores**

Aaron Fink: 800 Biology, 800 Physics, 800 Math

Harry Huntley: 800 Math

Willie Povell: 800 Reading

Jonathan Stonely: 800 Reading, 800 Math

Max Yuhas: 800 Math

National Merit Scholars

Semifinalist

Max Yuhas

Commended Students

Cullen Bray, Shoshana H. Brody, Aaron R. Fink, Benjamin L. Garlow, Rebecca Gearhart, Harry Huntley, Kyle L. Low, William L. Povell, Henry J. Sin, Humza U. Yaqoob

William R. King Chapter of the National Honor Society

Ten Ingenuity students were inducted:

Ben Baitman, Olivia Birkel, Sarah Bowden, Sophie Cargnel, Caitlin Cole, Emma Eklund, Lauren Fink, Anisa Hofert, Eric Noffsinger, Sydney Rosebrough, Monika Watat, Amy Zhang

Northrop Grumman High School Innovation Challenge

The following Ingenuity students worked on the annual STEM challenge posed by Northrop Grumman engineers; they received 3rd place for their project:
Iven Chen-Van Dyk, Caterina Erdas, Robin Graham-Hayes, Anisa Hofert, Jakob Lucas, Martin Orellana-Guzman, Amy Zhang

National History Day

Ninth grader Amanda Berry will represent Baltimore Polytechnic Institute in this year's National History Day competition at the University of Maryland College Park on June 13-16, 2016. Amanda placed 2nd in the senior division individual documentary competition with her documentary on the Hubble Space Telescope.

Ingenuity Award Descriptions

Ingenuity Award Descriptions

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 has consistently demonstrated advanced topical skill and has received outstanding competition scores, as applicable as determined by the primary mathematics teacher.

The Highest Average Award for Mathematics is presented to the student in each primary mathematics class who has earned the highest average in mathematics.

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

The Highest Average Award for Science is presented to the student in each primary science class who has earned the highest average in science.

The Research Poster Award is presented to the sophomore, junior, and senior whose poster is able to captivate observers' interest in the research topic and shows excellent design as noted by a general audience of faculty, staff, and students.

The Stephanie Franklin Miller Research Scholarship for Juniors is presented to the junior who Ms. Miller selects based on a written submission highlighting the student's dedication to and the overall significance of the science research. 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 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 his or her peers and teachers in the Research Practicum program. This award is supported by Mr. and Mrs. John Saylor, the parents of former Ingenuity research coordinator Charlotte Saylor, in memory of her grandfather, John Claude Saylor, a teacher of physics and mathematics who demonstrated admirable dedication to the teaching profession and became a lifetime learner in his "quest to know."

The Britni Lonesome STEM Achievement Award is presented to the senior who has distinguished him or herself by exceptional work in computer science, computer engineering or data science.

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. This award was established by the Hill family (Owen, class of 2006 and Albert, class of 2003) in loving memory of their mother.

Ingenuity Award Descriptions

The Leadership Award is presented to the student in each grade level who have demonstrated outstanding leadership, as well as initiative in helping others and contributing to the welfare of the whole high school community as noted by their peers and teachers. Seniors who receive this award are also presented with a college scholarship.

The Esprit de Corps Award is presented to the student in each grade level who have demonstrated academic excellence, enthusiasm for extracurricular activities, and friendliness to all as noted by their peers and teachers. Seniors who receive this award are also presented with a college scholarship.

The 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 by Ms. Costa and selected 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. Seniors who receive this award are also presented with a college scholarship.

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.

RECOGNITION

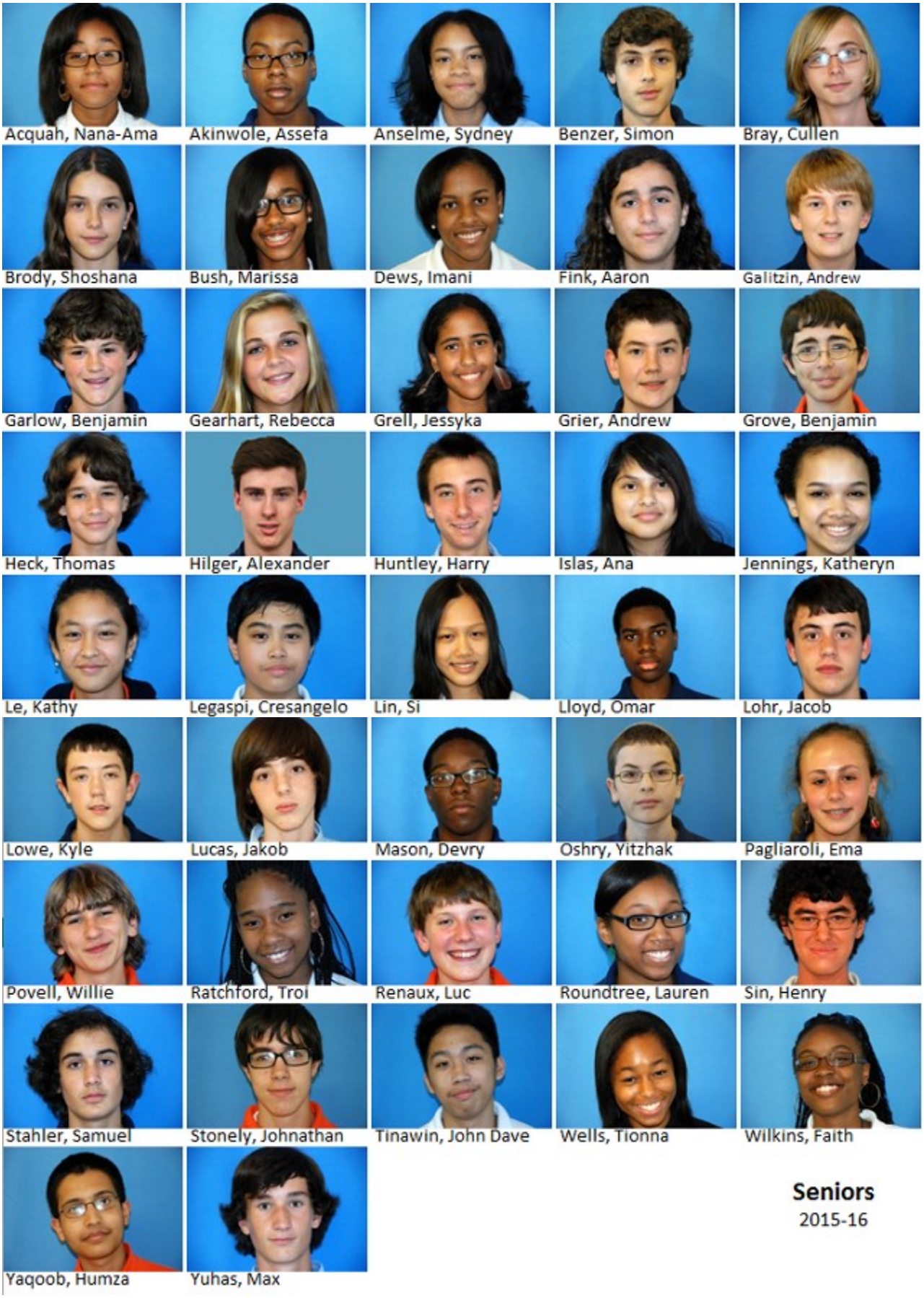
Maryland Mathematics League Certificate of Merit

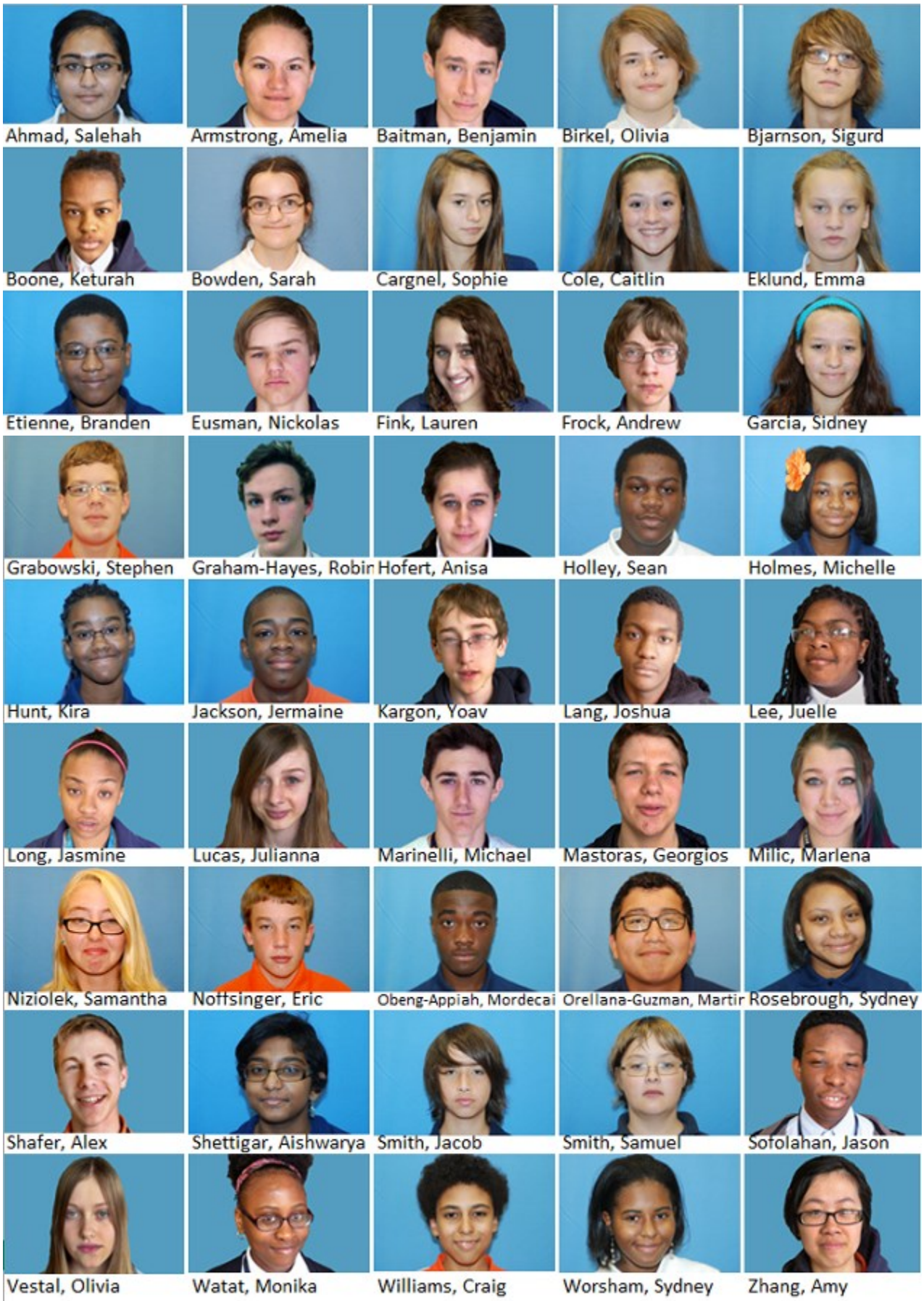
American Mathematics Competition 10 School Winner

American Mathematics Competition 12 School Winner

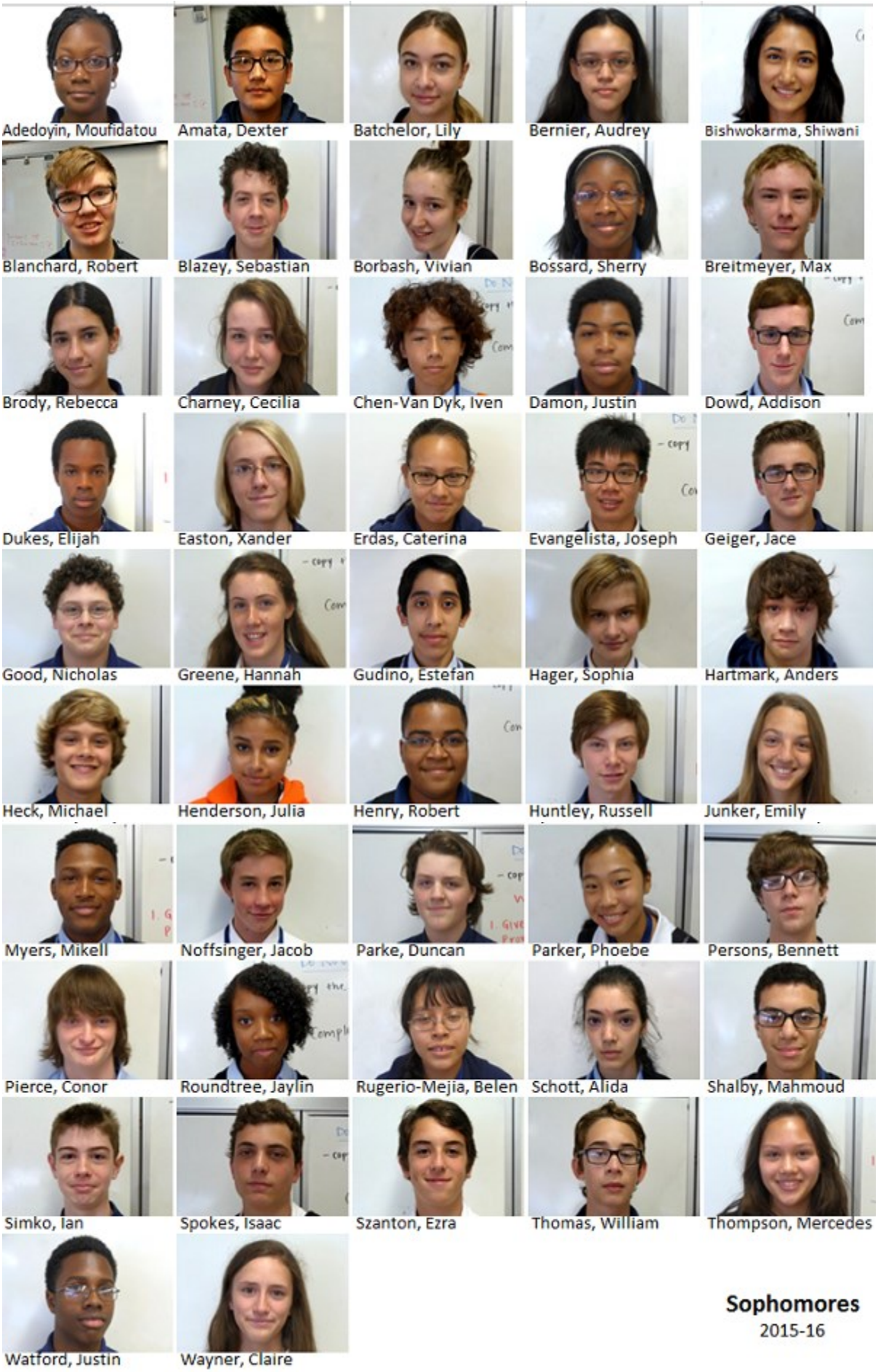
University of Maryland High School Mathematics Competition City Winner

Class Photos





Juniors
2015-16



Sophomores
2015-16

Freshmen

2015-16

Acknowledgements

The Ingenuity Project would like to acknowledge the support of: Baltimore City Public Schools, The Abell Foundation, T. Rowe Price Foundation, Lockhart Vaughan Foundation, Joseph and Harvey Meyerhoff Family, Thomas Wilson Sanitarium for the Children of Baltimore City, Goldseker Foundation, Harry & Jeanette Weinberg Foundation, Jack Kent Cooke Foundation, Aaron and Lillie Straus Foundation, Jacob and Hilda Blaustein Foundation, Hoffberger Family Philanthropies, Northrop Grumman, Robert W. Deutsch Foundation, and the Alvin and Fanny B. Thalheimer Foundation.

Our supporters maintain Ingenuity as the longest-standing advanced STEM program in Baltimore City.

The accomplishments of Ingenuity students would not be possible without the commitment and support of board members, scientists and faculty across Baltimore City.

Ingenuity Project Board of Directors

Chair	Ben Yuhas, Ph.D.	
Vice Chair	Steven A. Farber, Ph.D.	
Secretary	Bonnie Legro, MAT	
Treasurer	Martin Lee, MS, MBA	
Members	Andrea Bowden, Ph.D.	Harris W. Eisenstein, Esq.
	Raveesh Dewan	John Easterling, AIA, LEED AP BD+C
	Lara Ohanian	Dawnielle Farar-Gaines, Ph.D.
	Stephanie Miller, MAT	James E. West, Ph.D.

Ingenuity Project Staff

Executive Director	Lisette Morris, M.S.
Associate Director	Sergei Zverev, Ph.D.
Dean of Students	Gale Fletcher, M.S.
Research Coordinator	David Nelson, M.S., MAT
Mathematics Department Head	Mikhail Goldenberg, Ph.D.
Admissions Coordinator	Vernise Bolden
College Advisor	Shani Ortiz, M.A.
Office Manager	Keyha Royster

Baltimore Polytechnic Institute Faculty and Staff

.

Director	Jacqueline Williams	
Assistant Principals	Matthew Woolston	Renay Leggett-Greene
	Gretchen Lawson	
Guidance	Kate Wickham	Wanda Williams
	Christian Lorenzo	Dwayne Green
	Anthony Harold	Jennifer Askey-Barton

Symposium Committees

Steering and Awards	Samuel Smith	Sam Niziolek	Sydney Worsham
	Andrew Frock	Robin Graham-Hayes	
Publicity	Branden Etienne	Jacob Smith	Anisa Hofert
Program	Yoav Kargon	Aishwarya Shettigar	Emma Eklund
	Stephen Grabowski		
Event Night	Ben Bjarnason	Olivia Birkel	Amy Zhang
	Sydney Rosebrough	Julianna Lucas	Jasmine Long
	Nick Eusman		