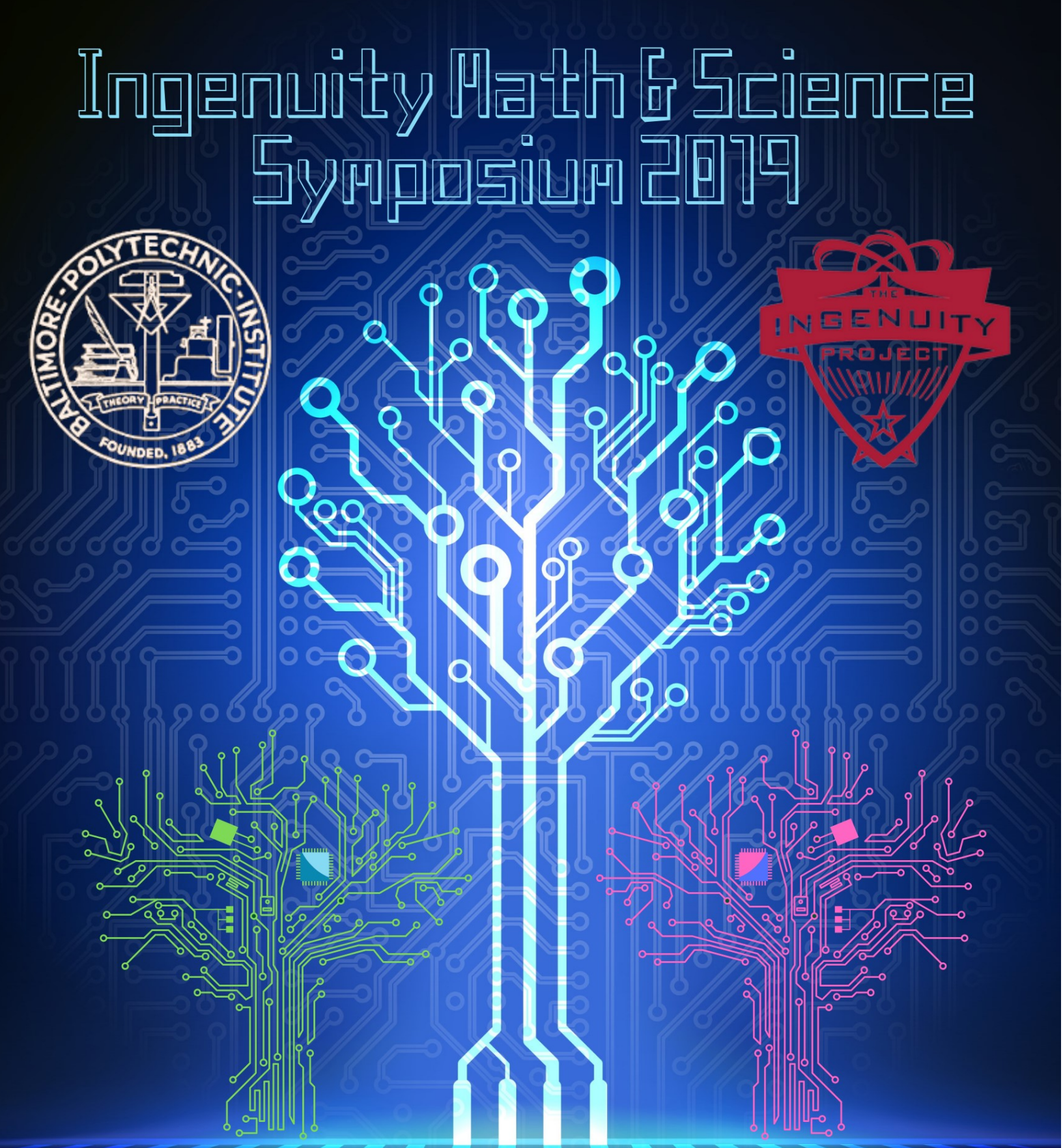
Ingenuity Math & Science Symposium 2019



Baltimore Polytechnic Institute

Wednesday, May 22, 2019

Ingenuity Project Sponsors

These sponsors support Ingenuity's quality and rigorous education for close to 750 middle and high school students in Baltimore City Public Schools for the 2019-20 school year.

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One Ingenuity teacher position will be named in honor of ABS Capital Partners.

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One Ingenuity student scholarship has been named in honor of each organization and recognized at the Mathematics and Science Symposium.

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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 five 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 Regeneron Science Talent Search, and financially rewarding, contests. Juniors and seniors submit their research to local science fairs as well, including the Junior Science and Humanities Symposium (JSHS) and Baltimore Science Fair (BSF).

Learn about Ingenuity's new Innovation Practicum and the students' areas of interest on page 39!

Mathematics Program

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

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

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

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Schedule of Events

5:00 - 5:45	Poster Viewing and Refreshments
5:45 - 6:10	Opening Comments by the Keynote Speaker
6:20 - 7:50	Student Presentations
7:50 - 8:45	Awards Ceremony

PRESENTATIONS

6:20 - 6:35

Banneker Hall	Detection of *Schistosoma Mansoni* DNA from Filtered Urine Samples Using a Multiplex PCR – ***Michelle Mokaya***
Room 119	Studying the Effects of Preventing Fetal Oocyte Attrition Using chk2 and Azidothymidine – ***Karen Griffin***
Room 120	Exonuclease-dependent protospacer processing during CRISPR-Cas immunity – ***Lily DeBell***
Room 121	A Rigorous Study of Limits – ***Elizabeth Zheleznyakova and Rachel Pontious***
Room 125	Analyzing Thalamic Inputs to the Area PSS in the Ferret – ***Chiad Onyeje***

6:45 - 7:00

Banneker Hall	Method of Substitution Solving Some Differential Equations – ***Evains Francois and Omobolade Odedoyin***
Room 119	Measuring Genetic Stability of an Ecologically Important Reovirus in Blue Crabs – ***Nathaniel Alper***
Room 120	Defective Autophagy In C9-ALS – ***Taylor Young***
Room 121	Diffusion of Platinum-coated Nanoparticles – ***Abby McKenna***
Room 125	Comparing Post-Merger Galaxy Evolution to Morphological Trends to Understand Galaxy Mergers- ***Rohan Kane***

7:10 - 7:25

Banneker Hall	Disrupting the Fatty Acid Binding Protein 2 Gene in Zebrafish Using CRISPR-Cas9 and a Gene Breaking Transposon – ***John Halpin***
Room 119	Computational Investigation of the Joining Rate of DNA Nanotubes – ***Elizabeth Zheleznyakova***
Room 120	Mathematical Theorems for Non-Mathematicians – ***Lily DeBell and Michelle Mokaya***
Room 121	Rolling Tack of the Medical Pressure Sensitive Adhesive Durapore in Air, Water, and a Phosphate Buffered Saline Solution - ***Raquel Legaspi***
Room 125	Innervation of the Human Esophagus – ***Ruth Martin***

7:35 - 7:50

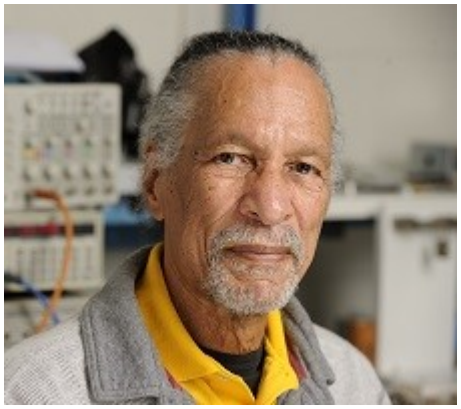
Banneker Hall	Famous Ancient Greek Problems and Why It's Impossible to Solve Them – ***Timothy Honablew and Ifasoke Owens***
Room 119	Influence of a Submerged Anoxic Zone on Nitrogen Removal and Denitrification Potential in Engineered Infiltration Systems – ***Rachel Pontious***
Room 120	Future Scholars Problem Set – ***Colton Ross and Nathaniel Apler***
Room 121	How Altering The Number of Antennae Affects a Cockroach's Navigational Behavior – ***Evains Francois***
Room 125	Quantifying Cochlear Top-Down Neural Input in a of Kabuki Syndrome Mouse Model – ***Omobolade Odedoyin***

AWARDS CEREMONY

7:50 - 8:45	**Banneker Hall**
MCs	Maya Pulliam, Fiona Zabel, Jarra Omar, Isaiah Roberts, and Raekwon Williams

About the Keynote

Dr. James West



Professor at Johns Hopkins University, Department of Electrical and Computer Engineering and the Department of Mechanical Engineering.

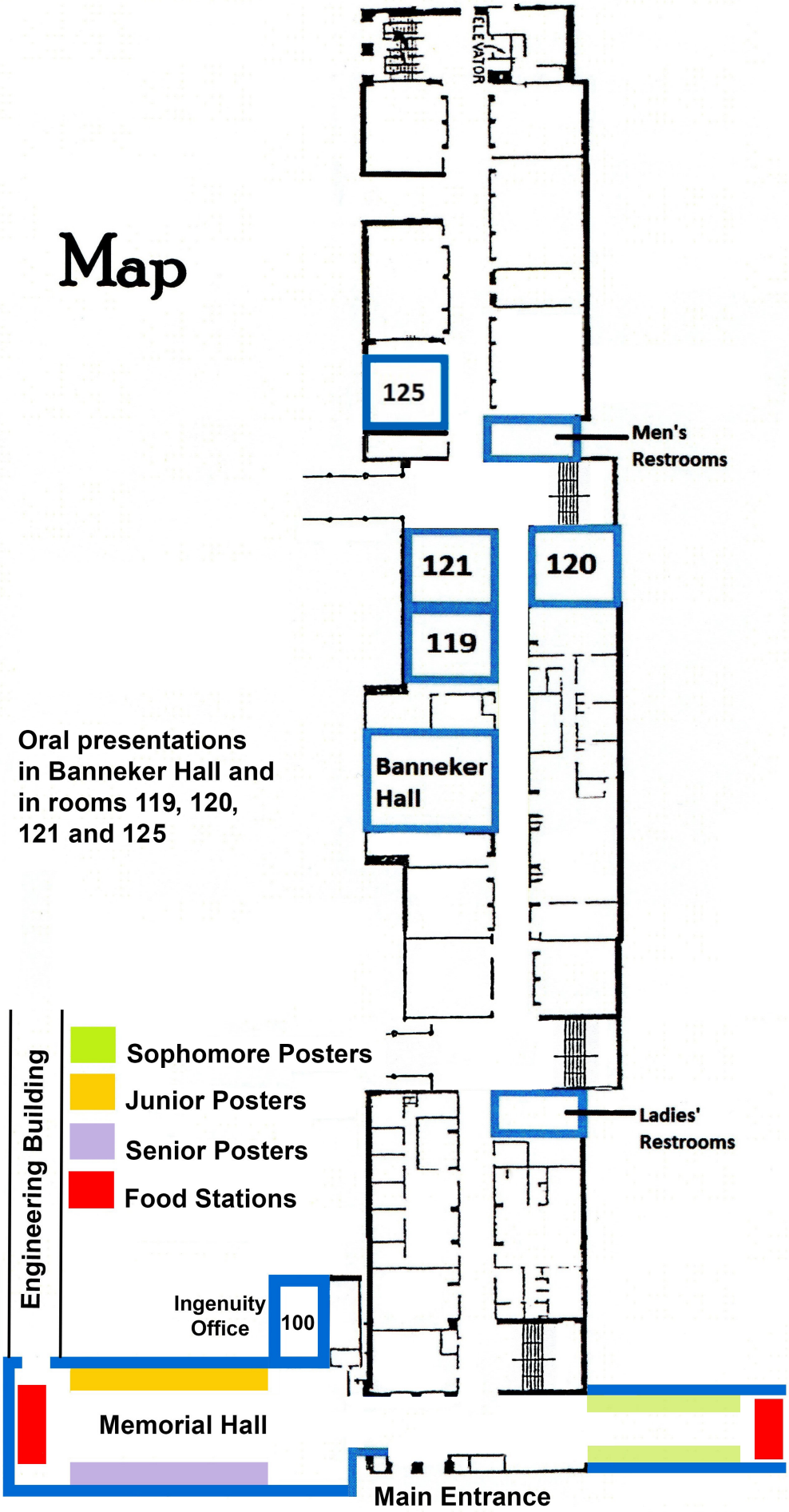
Dr. West holds over 250 foreign and U.S. patents for the production and design of microphones and techniques for creating polymer foil electrets. He had a distinguished 40-year career at Bell Laboratories where he received the organization's highest honor, being named a Bell Laboratories Fellow. In 2001, he joined the faculty of the Whiting School of Engineering at Johns Hopkins University where he is currently a professor.

Along with Gerhard Sessler, Dr. West invented the foil electret microphone in 1962 while developing instruments for human hearing research. Compared to the previous condenser microphones, the electret microphone has higher capacitance and does not require a DC bias. They optimized the mechanical and surface parameters of the system. Nearly 90 percent of more than two billion microphones produced annually are based on the principles of the foil-electret and are used in everyday items such as telephones, camcorders, hearing aids, baby monitors, and audio recording devices among others. Dr. West measured the acoustics of Philharmonic Hall in New York City. Recently, he teamed with Ilene Busch-Vishniac and studied the acoustic environment of hospitals showing that hospitals are in general too loud and that the noise levels affect staff and patients. Dr. West is still an active inventor working on a device to detect pneumonia in infant lungs.

In addition to his many contributions to acoustical science, throughout his career Dr. West has been a fervent advocate for greater diversity in the fields of science and technology. While at Bell Laboratories, West co-founded the Association of Black Laboratory Employees, an organization formed to "address placement and promotional concerns of Black Bell Laboratories employees." He was also instrumental in the creation and development of both the Corporate Research Fellowship Program for graduate students pursuing terminal degrees in the sciences, as well as the Summer Research Program, which together provided opportunities for over 500 undergraduate students of color. Since 2015, Dr. West has served on the Board of Directors of The Ingenuity Project, a Baltimore non-profit that supports talented middle and high school students in science and math.

Dr. West is the recipient of the National Medal of Technology and Innovation, and in 2010, along with Gerhard M. Sessler, he was the recipient of The Franklin Institute's Benjamin Franklin Medal in Electrical Engineering. He is also an inductee to the National Inventors Hall of Fame and an elected member of the National Academy of Engineering. He is also the recipient of numerous other honors and awards, including five honorary doctorate degrees.

Map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Senior Research Abstracts

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

Back row (from left to right): Chiad Onyeje, Nathaniel Alper, John Halpin, Abby McKenna, Evains Francois, Rohan Kane, Omobulade Odedoyin

Middle row (from left to right): Ruth Martin, Rachel Pontious, Elizabeth Zheleznyakova, Michelle Mokaya, Taylor Young

Front row (from left to right): Tori Legaspi, Lily DeBell, Sumaita Ahmed, Karen Griffin

Senior Research Abstracts

Localization of Cohesin Accessory Factor ECO-1 in Meiosis
Sumaita Ahmed

Mentor: Dr. Yumi Kim
Supervisor: Jocelyn Haversat
Institution: Department of Biology, Johns Hopkins University

The focus of my independent project is on the acetyltransferase, ECO-1, an ancillary component to cohesion complex. Cohesin refers to a multicomponent protein complex that is a major constituent of both mitotic and meiotic chromosomes. This proteinaceous structure has three functions; among them is mediation of sister chromatid cohesion. Cohesin's role in the union of sister chromatids makes it essential in ensuring correct chromosome distribution during meiotic prophase. My protein of interest, ECO-1, is uncharacterized and unstudied. Scientists believe that this protein is necessary for the establishment and release of cohesion. Since there is no existing literature available on this protein within the *C. elegans*, my model system, the focus of my project is to localize the protein and confirm its presence within the germline.

Measuring Genetic Stability of an Ecologically Important Reovirus in Blue Crabs
Nathaniel Alper

Mentor: Dr. Eric Schott
Institution: Institute of Marine and Environmental Technology (IMET), University of Maryland

CsRV1 is a virus in the family Reoviridae which infects blue crabs. Its RNA genome is highly mutatable and does not pass from female to offspring or travel within larvae. Therefore, genetic similarities between CsRV1 populations could be an indication of physical travel of mature crabs, which would assist in making an accurate model of adult crab movements. To create such a model, it is necessary to assess the variability of a given population of CsRV1 in order to collect data more efficiently. To investigate this, I studied the stability of a section of the CsRV1 genome from crabs caught in Rhode River, MD and Georgica Pond, NY in seven different years. In 27 sequences around 720 bases long, there was a large amount of genetic variation, with the maximum nucleotide difference between sequences being 15 bases, or 97.91% identity. Rhode River was more diverse than Georgica Pond, likely because Rhode River has more adult crab migration, whereas Georgica Pond is more isolated. The variation cannot be predicted by year over this time frame. Given how variable each year is, even a single year with many sequences of the wild genotype is as useful as multiple years of only a few sequences. When studying the crab population using the virus, it should not be necessary to collect data from a location every single year, but it is important to have at least one year with a thorough data set. Collecting crabs with this in mind could save time and resources.

Senior Research Abstracts

Exonuclease-Dependent Protospacer Processing During CRISPR-Cas Immunity
Lily DeBell

Mentor: Dr. Scott Bailey
Supervisor: Anita Ramachandran
Institution: Department of Biochemistry and Molecular Biology, Johns Hopkins Bloomberg School of Public Health

CRISPR-Cas systems are the adaptive immune systems of bacteria and archaea. CRISPR systems allow cells to develop immunological memory by storing information from foreign DNA in the bacterial or archaeal genome itself. Adaptation, the stage of CRISPR immunity during which foreign DNA is incorporated into the prokaryotic genome, is an essential but poorly understood aspect of CRISPR-Cas immunity. In the current model, foreign DNA fragments are recognized, processed, and integrated during adaptation by a complex of two CRISPR-associated proteins. Cas1, the catalytic subunit of this complex, is a metal-dependent endonuclease. The means by which Cas1 facilitates integration of suboptimal fragments into the host genome are unknown. I determined optimal metal conditions and the role of host DNA exonucleases for Cas1-Cas2 facilitated integration of DNA into a CRISPR array in an in vitro E. coli CRISPR system. Integration of suboptimal substrates was supported in the presence of E.coli DnaQ, while adaptation could not be rescued in the presence of other E. coli exonucleases, suggesting a unique role for DnaQ in processing foreign DNA during adaptation. Future work includes determining the mechanism by which three-nucleotide motifs which allow Cas1 to discriminate between self and nonself DNA are cleaved on foreign DNA fragments prior to integration.

How Altering The Number of Antennae Affects a Cockroach's Navigational Behavior
Evains Francois

Mentor: Dr. Chen Li
Supervisor: Rick Han
Institution: Department of Mechanical Engineering, Johns Hopkins University

Cockroaches, along with many other insects, use antennae as their primary method of sensing. Because of their success in navigation through rough and cluttered terrain, scientists are now looking at antennae to be a potential method for robot navigation. In this study, cockroaches with varying number of antennae were placed on a treadmill-like contraption to investigate the affects that different antennal interactions have on the animals' response. I observed how often they collided with obstacles, which direction they would turn when an antenna touched an obstacle, and many other aspects of the collision. After analyzing my data, I found that as the cockroaches touched a pillar, they tended to turn away from the obstacle to prevent them from colliding. It was also noted that cockroaches with a fewer number of antennae tended to collide more often with the pillars than cockroaches with more antennae. Knowing how cockroach behavior changes when an antenna is removed can help give insight on creating a protocol to use when an artificial antenna is damaged on a future cockroach inspired robot.

Senior Research Abstracts

Studying the Effects of Preventing Fetal Oocyte Attrition Using chk2 and Azidothymidine
Karen Griffin

Mentor: Dr. Alex Bortvin
Supervisor: Marla Tharp
Institution: Carnegie Institution of Science, Department of Embryology

Mammals are limited to the number of oocytes that they have at birth, which only represents a small fraction of what the body had originally produced during fetal oogenesis, the creation of oocytes while the body is an embryo. Fetal oocyte attrition (FOA) is the phenomenon where the mammalian body destroys most, around 80%, of its produced oocytes before birth. Checkpoint kinase 2 (*chk2*) is a DNA damage checkpoint gene involved in FOA that destroys damaged cells. Mice with the absence of *chk2* and the addition of azidothymidine (AZT) retain their original number of oocytes produced. The overall goal of my project is to determine if the prevention of FOA is beneficial and identify key differences in ovaries that do not go through FOA compared to the control. To answer my research goal, I analyzed the ovaries of different genotypes at different postnatal stages of development.

Disrupting the Fatty Acid Binding Protein 2 Gene in Zebrafish Using CRISPR-Cas9 and a Gene Breaking Transposon
John Halpin

Mentor: Dr. Steven Farber
Supervisor: Ms. Monica Hensley
Institution: Carnegie Institute for Science, Department of Embryology

Fatty acid binding protein 2 (Fabp2) is a protein that binds to fatty acids and is involved in their uptake and metabolism. It is agreed that Fabp2 is involved in intracellular lipid transport, but how it achieves this remains poorly defined. One method of studying gene function is by generating and identifying mutations in the gene of interest, which I did with the Fabp2 gene using two lines of mutant zebrafish. The first line has an insertion in Fabp2 by the protein trap RP2, which contains a transposon (DNA sequence that inserts into the genome) with monomeric red fluorescent protein (mRFP). This allows for the simultaneous knockout of the gene and expression of mRFP since it is expressed in the same cells as the interrupted gene. Using a fluorescent microscope, I imaged RFP expression in the yolk syncytial layer, an extraembryonic nutrient-metabolizing organ, through 7 days post fertilization. However, I observed no obvious morphological or metabolic phenotypes of Fabp2 disruption. A second mutant line was created by inducing a double stranded break at a targeted region of Fabp2 using the CRISPR-Cas9 complex. While the cell repairs the break, it often isn't repaired precisely, thereby inducing a mutation in the gene. Using the polymerase chain reaction and gel electrophoresis, I identified mutants and bred them to create a stable mutant line. From this second generation, I identified six unique mutations in the gene that could lead to complete disruption of its function, creating valuable tools for further study of Fabp2 function.

Senior Research Abstracts

Comparing Post-Merger Galaxy Evolution to Morphological Trends to Understand Galaxy Mergers
Rohan Kane

Mentor: Dr. Jennifer Lotz
Institution: Space Telescope Science Institute, Johns Hopkins Bloomberg Center for Physics & Astronomy

Galaxy morphology is a field of astronomy that attempts to classify galaxies based on their characteristics, which has a relatively new area of galaxy mergers that tries to discover how dynamic interactions between galaxies cause the system to change. Most information about galaxy mergers is largely based on quantitative data rather than qualitative data, as telescopes provide information in a format which is easy to read and analyze. By performing image subtractions with the python programming language on images of galaxies to reveal extraneous features, I classified visual observations and compared them to the Gini/M20 ratio, a ratio of Asymmetry/Smoothness/Concentration, and shape asymmetry, all morphologies commonly accepted as describing galaxy mergers. In this, I attempted to discover trends between quantitative and qualitative data among galaxy mergers. However, in part due to the limited sample set, I was unable to significantly differentiate data trends between stratifications.

Rolling Tack of the Medical Pressure Sensitive Adhesive Durapore in Air, Water, and a Phosphate Buffered Saline Solution
Raquel Legaspi

Mentor: Dr. Joelle Frechette
Supervisor: Preetika Karnal
Institution: Department of Chemical and Biomolecular Engineering, Johns Hopkins University

Tack, the property of a pressure sensitive adhesive (PSA) to bond with a surface under slight pressure, has made PSAs idyllic in a medical setting, where wound dressings need to be frequently changed, or medical devices need to be temporarily attached to a patient. Medical adhesives, which frequently come into contact with bodily fluids, must be able to adhere to the skin under wet conditions. Here, the tack of Durapore is characterized in air, water, the common base of all bodily fluids, and a phosphate buffered saline solution, which has a similar osmolality with bodily fluids. A rolling ball tack test method established by the Pressure Sensitive Tape Council was used. A custom-made rolling apparatus resembling that of the standard in a rolling ball test and four Aluminum balls of varying diameters from 4.7 mm to 12.7 mm was used. It was found that the tack decreased from air to water to the PBS solution.

Senior Research Abstracts

Innervation of the Human Esophagus
Ruth Martin

Mentor: Dr. Jana Harasaniova
Supervisor: Marian Kollarik
Institution: Kollarik Lab, Department of Neurology, Johns Hopkins Bayview Medical Center

Esophageal afferent nerves, also known as sensory nerves, regulate esophageal function and mediate painful sensations. Therapies targeting esophageal afferent nerves would alleviate symptoms and pain in many patients with esophageal diseases. However, insufficient knowledge of esophageal afferent nerves hampers the development of such therapies. The information about esophageal afferent nerves is obtained in animal models using mice and guinea pigs. However, it is unknown how the information from animal models translates to human nerves. We hypothesized that the esophageal tissue obtained from human organ donors is suitable for the analysis of the structure of esophageal nerves. We found that all tissue layers in human donor esophageal tissue were preserved and discernible. The nerves can be clearly visualized by immunostaining for pan-neuronal marker PGP9.5 and putative C-fiber marker CGRP. We concluded that the immunostaining of human donor esophageal tissue is a promising approach to validate the translatability of the knowledge of esophageal nerves obtained in animal models.

Diffusion of Platinum-coated Nanoparticles
Abigail McKenna

Mentor: Dr. David Gracias
Supervisor: Gayatri Pahapale
Institution: Whiting School of Engineering, Johns Hopkins University

Cancer is one of the leading causes of death across the globe. Present treatment methods, including chemotherapy and radiation, are highly intrusive and cause drastic side effects, causing research to turn to autonomous micromotors as a noninvasive solution. These devices serve as drug-bound carriers for delivering antibiotics directly to the cancerous tumor, thus providing a targeted treatment. The tumor extracellular matrix in the tumor microenvironment is an obstacle to successful diffusion as it traps the particles in its dense mesh structure. Here, I demonstrated the non-Brownian, active motion of a platinum-peroxide based micromotor. Platinum-coated particles were created by evaporating a layer of platinum overtop fluorescent particles. Platinum catalyzes the decomposition of hydrogen peroxide, propelling oxygen gas which provides propulsion to the particle. To recreate the matrix, gelatin is included in the system and forms the same mesh structure. As the concentration of gelatin included increased, particle displacement decreased: a tighter mesh structure is formed increasingly trapping the particles and inhibiting their motion. Additionally, platinum-coated particles with peroxide had the greatest velocities as compared to plain fluorescent particles and platinum particles without peroxide, as determined by their mean squared displacements. This confirmed my hypothesis as the platinum/ peroxide system created a thrust increasing displacement. Together, these results show that this experimental system can be used to demonstrate the diffusion of autonomous motors and to optimize such motion. Future research will include the incorporation of an antibody for delivery and release to the tumor.

Senior Research Abstracts

Detection of *Schistosoma Mansoni* DNA from Filtered Urine Samples Using a Multiplex PCR
Michelle Mokaya

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

Many parasitic infections show no obvious clinical symptoms due to low levels of parasitic DNA present in one's system. To address this issue, a new approach of detection using polymerase chain reaction (PCR) has revealed promising results as a highly sensitive diagnostic test. The goal of this project was to develop a highly sensitive multiplex assay which will be able to detect the presence of *Schistosoma mansoni* by targeting a highly repeated DNA fragment and amplifying the parasitic DNA present. A multiplex PCR is a procedure which uses more than one primer set to target multiple DNA templates in the same reaction mixture. Through PCR and gel electrophoresis, this project uses parasitic primer sequences to target parasitic DNA and human primers sequences to target human DNA in filtered urine samples. The project was able to establish a working multiplex protocol to amplify *S. mansoni* DNA and suggests that DNA amplification of urine samples is a viable diagnostic tool. In the future, this protocol can be optimized and applied to accommodate the DNA amplification of other parasites.

Quantifying Cochlear Top-down Neural Input in a of Kabuki Syndrome Mouse Model
Omobolade Odedoyin

Mentor: Dr. Amanda Marie Lauer
Institution: Department of Otolaryngology, Johns Hopkins University

Kabuki syndrome (KS) is a multisystem disorder with classical phenotypic features, including distinctive facial features, skeletal abnormalities, and mental retardation. KS has been discovered to lead increased susceptibility of severe hearing impairment in affected children. Overlooked hearing loss may exacerbate negative cognitive outcomes. My project focused on the top-down auditory olivocochlear system alterations, specifically in the medial and lateral olivocochlear (MOC and LOC) systems, in response to chronic exposure to background noise. Two different age groups of young mice were exposed to the same chronic moderate noise conditions with either immediate tissue harvest or harvest following restoration to quiet conditions, with age-matched controls. Cochleae were dissected and standard immunohistochemistry protocols were used to label hair cells with antibodies against myosin 6 and olivocochlear synaptic terminals with synaptic vesicle protein 2 (SV2). Specimens were imaged using confocal microscopy, and density of SV2 labeling was quantified. There was no statistically significant difference in MOC SV2 density between mice raised in noise and age matched controls for any group. However, there was a statistically significant increase in LOC SV2 density for adult mice raised in noise, particularly at higher frequency regions. This could suggest a protective upregulation of the efferent system against chronic moderate noise exposure. The increase in LOC innervation persisted for juvenile mice raised in noise with subsequent restoration to quiet conditions. These data suggest that the LOC system demonstrates sound-dependent plasticity, but that synaptic morphology may be altered for a substantial time period after exposure to noise ceases.

Senior Research Abstracts

Analyzing Thalamic Inputs to the Area PSS in the Ferret
Chiad Onyeje

Mentor: Dr. Kristina Nielsen
Supervisor: Augusto Abel Lempel
Institution: The Zanvyl Krieger Mind/Brain Institute, Johns Hopkins Krieger School of Arts & Sciences

The anatomical organization of the visual pathway is constantly being studied alongside the analysis of functions found in those same connections. Before the function of a signal can be completely understood, the location where that signal transmits to and from needs to be solved. Therefore, an early stage in the visual pathway, such as the thalamus, is an invaluable asset to analyzing anatomical organization further on in the pathway. The thalamic region has shown connection to the posterior suprasylvian area (PSS) in the ferret. Tracer labeling in the thalamus when a retrograde tracer was previously injected in the PSS showed reception across the lateral geniculate nucleus (LGN). When compared across ages, starting from eye-opening to adulthood, a dramatic decrease in labeling occurred as the age increased. Consistency was found in adult LGN labeling only occurring in the C layer of the LGN, with kits holding label across layers A, A1, and C. Both kits and adults still saw consensus in the C layer, providing a majority, if not all the connection to the PSS. This accurately accounts for the much narrower connections found in developed brains which specialize certain neurons for specific tasks.

Influence of a Submerged Anoxic Zone on Nitrogen Removal and Denitrification Potential in Engineered Infiltration Systems
Rachel Pontious

Mentor: Dr. Sarah Preheim
Supervisor: Yue Zhang
Institution: Department of Environmental Health and Engineering, Whiting School of Engineering, Johns Hopkins University

Stormwater, or rainwater that often washes pollutants from land to water, is a major source of nitrogen pollution, which impacts water quality in many ways. These include promoting potentially toxic algal blooms and depleting oxygen from water. Engineered infiltration systems (EIS) are used to remove nitrogen from stormwater after a rain event, often through a biological process performed by bacteria, called denitrification. EIS are sometimes modified with a submerged anoxic zone (SAZ) to promote denitrification. However, the effect of SAZs on denitrification potential in EIS, and their effectiveness in EIS with different levels of microbial diversity is unclear. In this study, I measured loss of nitrate and denitrification potential in experimental EIS columns with and without an SAZ. The SAZ columns generally removed all nitrate added to them, whereas non-SAZ columns only removed some nitrate. SAZ columns also removed more total nitrogen as a whole than non-SAZ columns. In investigating column contamination, I found that columns with different community compositions that were all modified with an SAZ performed similarly to each other in nitrogen removal. It is likely that denitrification drove the difference between the SAZ and non-SAZ columns' nitrogen removal efficiencies. This research demonstrates that the selective pressure of the SAZ promotes the growth of organisms capable of denitrification, but limiting diversity on the column may limit denitrification potential, impacting nitrogen removal. A more in-depth understanding of the stormwater pollution-removing potential of EIS can help to minimize the harmful effects of pollutants such as nitrogen in bodies of water.

Senior Research Abstracts

Defective Autophagy In C9-ALS
Taylor Young

Mentor: Dr. Tom Lloyd
Supervisor: Kirstin Maulding
Institution: Department of Neurology, Johns Hopkins University School of Medicine

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease that affects the nerve cells of the individual who has it. The most common genetic cause of ALS is a GGGGCC repeat expansion within the gene C9ORF72. Although there is currently no cure for the disease, axonal transport defects have been shown to contribute to the beginning of ALS. Axonal transport is the process responsible for the movement of many cell components along the axon of a neuron. Autophagosomes are one of the components that are transported by this process. Autophagosomes play a major role in the degradation of damaged or surplus cytoplasmic cargo. The process of autophagy refers to the degradation of these components by fusion with the lysosome. However, in ALS, the autophagic system displays defects in movement and amount of autophagosomes. Drosophila is a useful animal model that can be used to study this defective autophagy in ALS. In this study, the autophagosomes of non-ALS Drosophila and ALS Drosophila were compared to determine and quantify the amounts of autophagosomes between the two genotypes. I found that the autophagosomal amounts in the ALS Drosophila were significantly lower than the amounts in the non-ALS Drosophila. My conclusion corroborates previous findings from other scientists in the field, adding to the validity of past studies and research. With the findings of this study, scientists will be assisted in determining the biogenesis of ALS.

Computational Investigation of the Joining Rate of DNA Nanotubes
Elizabeth Zheleznyakova

Mentor: Dr. Rebecca Schulman
Supervisor: Dr. Michael Pacella
Institution: Department of Chemical and Biomolecular Engineering, Johns Hopkins University

The miniaturization of modern technology requires the development and investigation of increasingly smaller components. DNA nanotechnology harnesses DNA's property of self-assembly – the ability to self-form predictable higher-order structures. As a result, structures can build themselves efficiently at the nanoscale, removing the necessity to manipulate them manually. Two DNA nanotubes with complementary ends can join together, potentially assembling large, complex nanotube architectures. To achieve this, the properties of DNA nanotubes and their motion, such as how fast they join, must be investigated. In my project, I optimize a computational model to characterize the joining rate of two DNA nanotubes. Using oxDNA, a coarse-grained molecular dynamics software package, I conducted numerical simulations of the motion of two nanotubes to determine whether or not their joining rate depends on their length. I developed a Python code implementing the forward flux sampling method for rare event simulations, which increases the efficiency of the oxDNA simulations and does calculations to determine the nanotubes' joining rate. Running the simulations with nanotubes of various lengths will allow me to mathematically model the nanotubes' joining rate as a function of their length. Once a mathematical model has been established, nanotube joining will become a more predictable and applicable process, and the simulations can be applied to complex and dynamic systems of multiple nanotubes. Functional nanotube systems have potential applications from medicine, to technology, to nanoscale structural engineering.

Senior Math Projects

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

Old Russian College Entrance Exams
Brandon Dillow and Juan Romero

Across the world, mathematics has always been a constant among high level education, but from country to country the level of mathematics expected at certain points in one's education can widely differ. Comparing American and Russian college entrance exams can paint a picture of the difference in levels of knowledge required to excel. The SAT only expects basic algebra, geometry, and trigonometry proficiency, while Russian college entrance exams expect much more. Even when looking at advanced math in the United States, the focus is heavily skewed towards calculus, ignoring advanced algebra and geometry. Even fifty years ago, Russian exams expected advanced algebra, geometry, and trigonometry knowledge far beyond that of American exams. Now, the entrance exams expect calculus knowledge, in addition to the advanced algebra and geometry knowledge required before. A sample of these problems can demonstrate the difference in Russian exams from American exams.

Mathematical Theorems for Non-Mathematicians
Lily DeBell and Michelle Mokaya

In his 1940 essay, "A Mathematician's Apology," English mathematician G.H. Hardy outlined the need for explanations of "...theorems which every mathematician will admit to be first-rate." The purpose of Hardy's essay was to detail the inner workings of a mathematician's mind to outside observers (in this case, several of Hardy's friends). His explanations were intended to be understandable to non-mathematicians, with the goal of demonstrating the beauty of mathematics to laypeople. In our project, we aim to extend Hardy's enduring work through proofs of several essential mathematical theorems. The theorems we proved include Euclid's proof of the infinitude of primes, the irrationality of the square root of two, the sum of the first n natural numbers, the definition of pi, repeated decimals, and the angle determined by arctan(½) + arctan (⅓).

Old Poly Math Exams
Adi Mwangi and Abby McKenna

Since Poly's founding in 1883, math, science, and engineering have been the cornerstones of education. Each year, the way these core courses are taught has advanced with the changing times as technology and expectation of the workforce expand as well. For this project, the evolution of mathematics at Poly is studied through the examination of "Old Poly Math Exams" from 1963, focused in intermediate algebra, advanced algebra, and geometry. While some of these problems are similar to what students in high school algebra encounter today, the majority of problems are much more advanced. Over the past fifty years, advancements in technology have lead to the everyday use of the calculator in the classroom setting, thus changing the way math is taught in schools. Today, algebra, geometry, and trigonometry have become of less importance as calculus has become more applicable in fields such as engineering, medicine, and statistics. In order to accommodate this calculus curriculum, algebra and geometry material has been compacted to the minimum necessary to prepare students for calculus in high school and beyond. For this project, problems from these previous exams are solved and compared to problems from modern-day mathematics classes.

Senior Math Projects

Future Scholars Problem Set
Colton Ross and Nathaniel Alper

Each year, Johns Hopkins University invites a select group of mathematically talented high school students in the Baltimore area to take part in college mathematics courses at JHU for free in the Future Scholars program. To gain entrance to this program, students must take a challenging entrance exam to show mastery of Calculus BC concepts and problem solving skills. We have selected several interesting problems from past Future Scholars exams to analyze. These problems include finding a pattern for all possible derivatives of a function and the dimmest point between two sources of light. We solved complicated integrals using trigonometric functions and Dirichlet's function of non-continuity, used substitutions to take the derivatives of lengthy functions, and utilized mathematical concepts like the squeeze theorem to evaluate the limit of a unique exponential function. We will demonstrate some unique strategies to attack these special and challenging problems used to find the most mathematically gifted high school students in Baltimore.

Maxima and Minima in Functions of Multiple Variables
Rohan Kane and Henry Hercules

In this study, we examine two methods of calculating extrema in multivariable calculus, as well as its connections to single variable calculus and the various applications of optimization. In Calculus AB, we learn that we are able to optimize a single variable function. This is done by computing a function's critical points, in which its derivative is either equal to zero or does not exist. You may then determine whether the critical point is a local maximum or minimum by finding the second derivative at this point, with a positive value giving a minimum and a negative value yielding a maximum. The real world application of maxima and minima include companies who need to maximize profits but need to take into account varying costs including materials, and workers among other things, or airlines that need to find a balance between travel time and fuel. In many functions of multiple variables, you may use the partial derivative method to find the extrema. The partial derivative is taken with respect to a single variable which is treated as would be in a single variable function, while the other variables act as constants. A critical point of a multivariable function is found at a point in which all partial derivatives are either equal to zero or do not exist. Depending on the discriminant of the second derivatives, one can describe the status of the critical point. If this discriminant is equal to zero, however, the partial derivative method is not sufficient. Another method involves the Lagrange multiplier λ, in which a condition is satisfied by a second equation $g(x,y,...) = c$. A new function is then introduced with a variable λ in the form $L(x,y,...,\lambda) = f(x,y,...) - \lambda(g(x,y,...) - c)$. The partial derivative process may then be used to find extrema of this new function. These methods will be explored through solving a number of multivariable equations.

A Rigorous Study of Limits
Elizabeth Zheleznyakova and Rachel Pontious

Limits are the foundation of calculus: they allow us to define derivatives, and by extension, integrals. When we studied limits, we gave the definition: if $\lim_{x \to a} f(x) = L$, this means that we can make $f(x)$ as close to L as we need by making x sufficiently close to a. But we can give a more mathematically rigorous description for a limit: the epsilon (**e**)-delta (**d**) definition. Using this definition, we can rigorously prove the fundamental limit theorems, including those about infinitesimals, bounded functions, sequences, and the sums and products of limits. These can be used to solve complex limit problems and provide the basis for more advanced calculus.

Senior Math Projects

Method of Substitution Solving Some Differential Equations
Evains Francois and Omobolade Odedoyin

Differential equations are equations that relate a function to its derivatives. The general form of a differential equation is y'=f(x,y) or y''=f(x,y,y'). The simplest differential equations are separable equations, which we can solve easily by integration. We accept that we know how to solve linear equations that require a basic substitution, but there are some equations that require special substitutions. Some first order equations that require special substitutions are Bernoulli, Homogenous, and Non-Homogenous. Second order equations require an even more complex substitution that reduces them to a first order. The purpose of these special substitutions is to ultimately sequentially convert the given equation into an equation of separable form, which we already know how to solve.

Famous Ancient Greek Problems and Why It's Impossible to Solve Them
Timothy Honablew and Ifasoke Owens

With a coordinate system of unit length, a compass, and a straight-edge, any geometric element that can be derived from a finite number of rational operations and square root extractions, can be constructed. This was proven by the Ancient Greeks. Much later, it was possible to demonstrate that the converse if also true, meaning that any desired element can be constructed if, and only if, it can be derived from the given elements by a finite number of rational operations and extractions of a square root. We will discuss and apply this statement by establishing a field containing all constructible elements and demonstrating that the roots of an irreducible cubic equations do not belong in this field and thus, cannot be constructed. We will use this fact to demonstrate that one cannot trisect arbitrary angles and that one cannot construct the side of the cube of volume two with just a coordinate system of unit length, a compass, and a straight-edge..

P4 AP Calc BC
Wilfred Tsung and Samuel Harkness

Utilized in scientific fields ranging from physics to chemistry, groups count among the most practically applicable of mathematical concepts. A group is defined as a set of elements, finite or infinite, under a binary operation, called the group operation, such that combined, the four fundamental properties of a group are met: closure, associativity, the identity property, and the inverse property. An in-depth explanation of groups, including cyclic and isomorphic groups, will be provided, utilizing specific examples and showcasing specific proofs, including the proof that all cyclic groups are in order *n* are isomorphic, to the group of *nth* roots of 1 under multiplication.

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.

Back row (left to right)***:*** Ari Harris-Kupfer, Caleb Clark, Jarra Omar, Raekwon Williams, Alexander Nishiura, Trinity Stephen, Fiona Zabel

Middle row (from left to right): Matt Arcillo, Isaiah Roberts, Mya Smith, Helen Schott, Maya Pulliam, Donaysia Torbit

Front row (from left to right): Miriam Herrera, Samantha Yoseph, Marie Badiola

Junior Research Abstracts

***V. cholerae* DNA Stability Test from Various Types of Filter Papers**
Matt Ervince S. Arcillo

Mentor: Dr. Kawsar
Supervisor: Dr. Jones
Institution: Center for Immunization Research, Johns Hopkins Bloomberg School of Public Health

V. cholerae, most commonly known as cholera, remains an urgent public health crisis in developing regions, specifically in Africa and Southeast Asia. The disease is spread through contaminated drinking water and can be fatal if not treated immediately. Its main symptoms include diarrhea and dehydration. Because of the lack of surveillance in certain regions, a definite number of infections and deaths is unavailable, but the global death estimate is approximately 150,000 annually. An increase in the need for surveillance of the disease, through early detection and genotyping, increases the need for cheaper materials and methods. Decreasing the cost for the DNA extraction process will help researchers in the affected regions study the behavior of cholera more effectively. For this study, we aim to compare the DNA concentrations over time that are preserved various filter papers, which are used to preserve DNA from samples, specifically the Whatman 903 Protein Saver Cards, Whatman W1, Fisher P8, paper towel, and a Cholera Rapid Diagnostic Test when extracting cholera culture DNA. I used the Chelex method to extract DNA from the filter papers and verify our results with PCR. Although the results have not yet been verified, the data show a consistency in concentrations over the four months of data collection, and that the standard filter paper brands, which are already used for DNA extractions, will be more effective than the non-conventional paper towels that we will be testing.

Detecting Tr-DNA: The Effects of Acidity on Transrenal-DNA detection
Marie Badiola

Mentor: Dr. Clive Shiff
Supervisor: Ana (Gaby) Madrigal
Institution: Johns Hopkins Bloomberg School of Public Health

Working with DNA is important because it is a modern way to detect differences between species, as well as a tool for early disease diagnosis. High concentrations of DNA are preferred because many protocols require a specific amount of DNA to be used. My aim is to optimize a urine DNA extraction procedure from filter paper utilizing different pH solutions. The DNA is then extracted by using a urine DNA extraction kit (Zymo Extract-All™ Urine DNA Kit), following the manufacturers protocol. To confirm that DNA is indeed viable for Polymerase Chain Reaction (PCR) after extraction, the extracted DNA then is amplified through a PCR using two different primer sets (Human Beta-Globulin and ALU-Human sequence). Results are visualized through gel electrophoresis, to find if that band for the specific gene was amplified. However, working with human DNA can be difficult because of how easily specimens can be contaminated. For every test, a negative water control is used and if it shows to be positive, it means that contamination occurred. It was found that the primer set amplifying the ALU-Human sequence was contaminated, as bands were amplified in the negative control. The Beta-Globulin primer set was successful in determining which pH worked best for the extraction. The solution made with water (pH 7) was most successful as bands were amplified in the both this solution and the positive control. High DNA concentrations improve research in developing diagnostics tests for genetic and infections diseases.

Junior Research Abstracts

Effects of Curvature on Topological Defects in Nematic Liquid Crystals
Caleb Clark

Mentor: Dr. Francesca Serra
Institution: Department of Physics and Astronomy, Johns Hopkins Krieger School of Arts and Sciences

Liquid Crystals (LCs) are a state of matter between solid and liquid. They are elongated on one side and tend to self-align along that side. Topological defects (TDs) are regions of disorder in ordered systems. In LCs, TDs form when the molecules are unable to self-align. They are present across many fields of physics and have applications in data storage and quantum computing. However, in LCs they are easiest to observe and manipulate. Moreover, TDs in LCs act as lenses, and manipulating their position is useful when controlling light. I am interested in defect formation around curved features in glass microchannels during the isotropic to nematic phase transition. I observe defect formation during the phase transition near "bumps" in glass microchannels. Defects are counted during two phases of the transition: when there are no longer LCs in the isotropic phase and just before the molecules regain their stable state of perpendicular mlecular alignment. In most cases, defects form near curved regions in the glass microchannels. This shows that defect formation is significantly affected by curvature of the bounding surface. I am interested in finding if different categories of TDs are affected by certain types of curved features. I also plan on testing the effects of "bumps" on TDs in other LC phases.

Carbon Isotope Stratigraphy
Ari Harris-Kupfer

Mentor: Dr. Maya Gomes
Supervisor: Dr. Dana Brenner
Institution: Morton K. Blaustein Department of Earth and Planetary Sciences, Johns Hopkins Krieger School of Arts and Sciences

The history of the Earth is written in the rocks. When sediment is deposited on the Earth's surface, it forms layers. The carbon isotope composition of these layers is similar to the carbon isotope composition of the environment they were formed in. As more layers form, they cover previous layers. By looking at multiple layers, a change in the carbon isotope composition is visible. The carbon isotope composition will change between layers as the environment changes, so signs of environmental change can be identified by looking through past layers. The environment that layers form in could be uniform or isolated to the environment of other locations in the world. This can be determined by whether the environment is regulated by seawater, which circulates around the world and maintains a global environment, or by porewater, which is limited to a local area and maintains a local environment. Thus, signs of environmental change found in the layers could be on a local or global scale. My research project is to determine whether the carbon isotope composition of layers from the Turks and Caicos are closer to seawater or porewater carbon isotope compositions. The knowledge of global or local carbon isotope compositions can help determine if any environmental change or geological events were limited to the Turks and Caicos or consistent around the world.

Junior Research Abstracts

Genetic Mapping and Analysis of *C. elegans transgenes*
Miriam Herrera

Mentor: Dr. Andrew Gordus
Supervisor: Elana Pyfrom
Institution: Department of Biology, Johns Hopkins Krieger School of Arts and Sciences

To survive starvation, *C. elegans* nematodes transition into a hibernation-like state called dauer. When a worm enters dauer, it takes past history into account to predict a food shortage. One important cue is population density, which the worm detects via pheromones. A high concentration suggests future food shortage and convinces worms to induce arrest. It is unknown how far into the past memory of pheromone influences the decision. Because pheromone is difficult to dynamically deliver, the Gordus Lab has genetically modified worms to express light-gated ion channels in pheromone-sensing neurons. A worm's pheromone perception can then be temporally manipulated using different intensities of light. The genes important for temporal encoding will be identified by combining these experiments with neuronal-signaling mutants. This requires that we cross the integrated lines and mutants. However, we first need to know the chromosomal loci of the transgenes to ensure successful crosses. My project is to locate the loci of three integrated transgenes by mating these strains to strains with chromosomal biomarkers, and then observing whether these phenotypes co-segregate. The phenotypic results will then be compared to hypothetical ratios based on possible chromosomal locations. There are no results as of now, but it is expected that each gene will be located on a separate chromosome.

Cold-Formed Steel Shear Wall Chord Stud Column Optimization for Seismic Performance
Alex Nishiura

Mentor: Dr. Benjamin Schafer
Supervisor: Astrid Fischer
Institution: Department of Civil Engineering, Johns Hopkins Whiting School of Engineering

Shear walls are an important structural system for absorbing lateral forces, which are commonly generated by seismic events. The large supporting columns, or chord studs, located on either end of a shear wall are responsible for dissipating the lateral strain into the ground and are a lacking area in the advancement of seismic engineering due to their less than desirable strength. It is easy to increase the strength of something by adding more material, but as this is not efficient, the goal is to design a better stud column that uses the same amount of material. This is done by performing elastic buckling analysis in a program called CUFSM to design a column cross-section with the same area but a higher predicted strength. Combining elastic buckling results with the Direct Strength Method, accounting for buckling mode interaction, leads to a single design value for a member's overall strength that can be compared to that of what is currently used. Analysis of a common stud column shows that it is very strong at resisting distortional buckling, but the overall strength is lacking because of local and global buckling mode failures. The resulting cross-section will be manufactured and physically tested to confirm the predicted strength. This is currently being worked on, but there is not yet enough data to adequately conclude anything.

Junior Research Abstracts

Determining Local/Auditory Projections Synapsed onto Somatostatin Interneurons
Jarra Omar

Mentor: Dr. Hey Kyoung Lee
Supervisor: Bryce Grier
Institution: The Zanvyl Krieger Mind/Brain Institute, Johns Hopkins Krieger School of Arts & Sciences

The loss of a sensory function causes a variety of complex and unique changes in the primary auditory cortex. The brain can compensate for this deprivation by heightening the remaining sensory functions; however, many of the underlying changes are still unknown. Conducting molecular and cellular research on the deprived visual cortex provides a basis for pharmaceutical drugs and rehabilitation for brain injuries and defects. This study aims to see the effects that visual deprivation has on somatostatin (SOM) cells from both local and auditory projections. Through immunohistochemistry and confocal microscopy, we can see synaptic connections onto SOM cells from both local projections and the primary auditory cortex. Our results have the potential to show that mice deprived of light may have synapses identified by colocalizations of fluorescent labels for anti-body Gephyrin but not PSD 95. However, the amount of colocalization sites for both anti-bodies were insignificant. If the new protocols are successful it is highly possible to see more synapses signified by colocalization. Once we determine the correct concentrations and percentages for our solutions used in immunohistochemistry, we will be able to replicate staining for future projects at our lab and highlight exact changes to potentially help establish new medical procedures.

Antiretroviral Therapy-Facilitated Changes in GLUT1 at the Blood Brain Barrier
Maya Pulliam

Mentor: Dr. Dionna Williams
Supervisor: Lisa Fridman
Institution: Department of Molecular and Comparative Pathobiology, Johns Hopkins University Medical Campus, Miller Research Building

Although available HIV therapies have increased, HIV-associated neurological conditions have also increased. HIV can infect all parts of the nervous system, with changes in the brain structure that can be observed within one week after infection. As a result, multiple studies have been able to display a link between HIV therapies and endothelial dysfunction. This endothelial dysfunction may be contributing to the development of HIV associated neurocognitive disorders. Specifically, part of this endothelial impairment may be an impairment of glucose transporters to the brain. Glucose is very vital to the brain since it is its main energy source. As a result, any impaired glucose transporters can be very serious and threatening for a patient. In looking at how HIV therapies affect the main glucose transporter present on these endothelial cells, GLUT1, we would get a better idea of the multiple effects HIV therapies have on the brain. The overall goal of this study is to assess the effect of ART on GLUT1 expression in primary human brain microvascular endothelial cells (HBMVEC), which line the blood brain barrier, by means of Western blot. Preliminary results have suggested that the drugs tenofovir, emtricitabine, and dolutegravir may produce an effect on the expression of GLUT1 in the cell, further supporting the notion that HIV therapies exert changes on the brain that directly contribute to the increase in neurological disorders, other complications in metabolism, etc.

Junior Research Abstracts

Identifying Possible Shorelines in the Northern Arabian Terrain of Mars by Reexamining Citron's Paper
Isaiah Roberts

Mentor: Dr. Kevin Lewis
Institution: Department of Earth and Planetary Sciences, Johns Hopkins University

Though not proven, evidence points to the possibility of water on Mars. One example is the possibility of shoreline features on Mars. Scientist Robert I. Citron claims that the reason for the current deformed status of the shorelines is a result of true polar wander (TPW). However, his data could potentially be flawed due to abnormal variations. In order to prove or disprove Citron, I am testing his methods in plotting the Arabian shoreline feature. A context camera (CTX) and a digital elevation model (DEM) using CTX images and geoprocessing programs were used to make elevation data. By replotting the proposed shorelines, I can get more precise elevation values. Although all data has not been gathered, current results suggest that Citron's data were not as precise as it should have been.

Investigating the Disappearance of Native Plants in Cities
Helen Schott

Mentor: Dr. Christopher Swan
Supervisor: Dorothy Borowy
Institution: Department of Geography and Environmental Systems, University of Maryland, Baltimore County

Native plant populations are declining in urban areas while non-native plant populations are increasing. Since native plants provide essential services to the ecosystem that non-native plants cannot provide to the same extent, it is important to understand and prevent further decline of native plant populations. Differing responses of native and non-native plants to water stress may explain this decline, due to the environmental conditions in cities being different from the surrounding rural areas. To investigate this hypothesis, stomatal conductance, a method for quantifying water stress, was measured in nineteen species of native and non-native plants grown in raised beds that contained either urban "fill" soil or topsoil. The fill soil in the plots had significantly lower soil moisture than the topsoil, so the plants growing in fill soil experienced more water stress. The significance of differences between each species' average conductance and variability in conductance between soil types was calculated to compare the groups' responses to water stress. No broad pattern was found in plants' responses to water stress by species origin and soil type, so the hypothesis that seeded native and spontaneous plants respond significantly differently to water stress is not supported. This implies that water stress is not a factor contributing to the disappearance of seeded natives in cities.

Junior Research Abstracts

Requirement of *HR4* for Oogenesis in Adult Female *Drosophila*
Mya Smith

Mentor: Dr. Daniela Drummond-Barbosa
Supervisor: Dr. Lesley Weaver
Institution: Department of Biochemistry and Molecular Biology, Johns Hopkins Bloomberg School of Public Health

Reproduction in living organisms can be influenced by several environmental factors. Stem cells are defined by their ability to differentiate in order to maintain maturing tissue. Some organisms such as adult males need germline stem cells in order to reproduce properly. Nuclear receptors are transcription factors that play key roles in several biological processes, such as reproduction, and respond to environmental factors. Nuclear receptors can also influence stem cell behavior. The *Drosophila* nuclear receptor, hormone regulator 4 (*HR4*), has yet to be tested with regards to an influence on oogenesis, but it is known to play a big role in ecdysone triggered gene cascade development in the germarium. *Drosophila* oogenesis is a powerful model system for studying aspects of development and reproduction in animals. The purpose of this study is to observe the process of oogenesis when there is a lack of *HR4* expression. To test this, I examined germline stem cell maintenance and germline cyst cell number. I found that *HR4* knockdown decreases the germline stem number significantly over a 14-day time period, but does not have an obvious affect to niche cap cell number, suggesting that *HR4* is a requirement for germline stem cell maintenance. I also found that *HR4* knockdown does not have a significant impact on cyst cell number over the 10-day time period. The cyst cells are differentiating, which suggests that the germline stem cells are proliferating properly without the assistance of *HR4*.

Enhancing the Sensitivity of the Detection of Parasite-Derived DNA in the Urine of Schistosomiasis Patients
Trinity Stephen

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

DNA of *S. mansoni*, a parasite causing schistosomiasis, could be found in low concentrations in one sample of human urine. By using *S.mansoni* DNA as a common medium to simulate other parasites that emit extracellular DNA, it is possible to enhance the sensitivity of standard urine diagnostic procedures to extract more DNA from one sample. When putting a controlled amount of *S. mansoni* DNA into a small amount of synthetic urine and minimizing the surface area of the filter the solution runs through, there should be more DNA for every DNA extraction done on the filter, and therefore less waste. After using the entire filter in two DNA extractions, there were computational issues in the first experiment, where Nanodrop values suggested there was 1100ng of DNA in the extraction when only 182ng of DNA was put into the synthetic urine initially. In the second experiment, the Nanodrop values suggested there was 160ng of DNA when 170ng was put into the synthetic urine, but major contamination in the water control by 160ng suggests variation in values. Future evaluation of the experiment would focus on how to avoid contamination and consistent illogical readings.

Junior Research Abstracts

The Effects of Hydrogel Physical Properties on Endothelial Colony Forming Cellular Networks
Donaysia Torbit

Mentor: Eugenia Volkova
Supervisor: Dr. Sharon Gerecht
Institution: Institute for Nanobiotechnology. Johns Hopkins University

Understanding the relationship between the formation of vasculature in relation to its growth site is important to me because it contributes to the overall spreading of aggressive cancers to its preferred secondary site. A finding from this sarcoma cell line could potentially be applied to understanding factors that influence other metastatic cell lines such as breast cancer. The purpose of this research is to determine the relationship between sarcoma tumors and the growth of formed vasculature surrounding it. This interaction has led to the migration of cancer cells from the primary site of the tumor. I used a co-encapsulation of endothelial colony forming cells (ECFC) and undifferentiated pleomorphic sarcoma cells to form spheroids. The migration rates of the cancer cells were recorded, and it was observed that the cells were migrating at great lengths from their original site. IMARIS programming was used to record the structure of the encapsulation. It was observed that the cancer cells were relying on the maturely produced vessel networks to venture out from the original location. This study can lead us to understand how these networks are formed and what is allowing them to form. Furthermore, it will allow for a greater understanding in the movement of the cancer cell through the vasculature. The mechanisms behind cancer cell migration will contribute to the understanding of the underlying factors for cancer spreading and may allow a future understanding of cancer extravasation

Targeting Glutamine Metabolism in M2 Tumor-associated Macrophages in Prostate Cancer
Raekwon Williams

Mentor: Dr. Jelani Zarif
Supervisor: Debebe Theodros
Institution: Department of Oncology- Prostate Cancer and the Bloomberg Kimmel Institute for Cancer Immunotherapy, Johns Hopkins University School of Medicine

M2 macrophages have the ability to suppress anti-tumor immune responses in lethal prostate cancer, leading to subsequent spreading of cancerous cells (metastasis) from the primary tumor. Unlike M2 macrophages, classically activated macrophages (M1 macrophages) can trigger anti-tumor immunity to eliminate pathogens and foreign cells types (such as tumors) in the human body. An amino acid, glutamine is heavily present in the tumor microenvironment of prostate cancer. It has been shown to play a crucial role in M2 polarization. The pathways at which M2 macrophages metabolize glutamine during polarization are not well understood. We hypothesize that finding differences in gene and protein expression between M1 and M2 macrophages in the presence and absence of glutamine can help to figure out ways to revert M2 macrophages to a M1 macrophages. Understanding the role that glutamine plays with M2 polarization will help develop ways to change the tumor microenvironment that will not promote the M2 polarization and survival. Gaining a better understanding of how M2 macrophages metabolize glutamine using transcriptional and metabolic analysis will help develop new antitumor immunotherapies.

Junior Research Abstracts

Deformability Activated Cell Sorting in Mouse Embryonic Fibroblast Cells
Samantha Yoseph

Mentor: Dr. Claire Hur
Institution: Hur Lab of Microfluidics Biophysics at Johns Hopkins University Whiting School of Engineering

Cost and accessibility are major elements affecting the quality of general healthcare of the public. To create simple, yet efficient products, researchers have miniaturized and specified biological processes through microfluidics, the ability to manipulate fluids on a microscale level. I am working to create a microfluidic device that will be able to isolate cells based on deformability with label-free methods, making cell filtration more effective in practice and application. By developing a deformability-activated cell sorting (DACS) device consisting of a single inlet through which cells enter, expanding into five outlets that filter out cells, I used cell deformation as a plausible biomarker. Mouse embryonic fibroblast (MEF) cells were used to determine how a knockout, or inoperable, gene may react when using the DACS device. While some results were inconclusive, the experiments involving wild type cells were successful in determining cell filtration patterns and movement. In the future, more testing will be done to the knockout and wild type cells for comparison purposes and to ensure the accuracy results. It is expected that knockout cells will filter in towards the center of the device while wild type cells will filter towards the wall of the device. This device will improve upon emergency and low-resource type medical applications, providing low cost treatment and ease-of-access.

Analysis of the Neurological Effects of Exposure to Superfund Sites
Fiona Zabel

Mentor: Dr. Michelle Carlson
Supervisor: Dr. Atif Adam
Institution: Department of Mental Health, Johns Hopkins Bloomberg School of Public Health

This study aims to investigate the association between proximity to superfund sites and risk of developing dementia as a population. The importance of understanding the effects of superfund sites is crucial due to site prevalence. There are currently 1,322 superfund sites on the National Priority List alone, most with significant human populations living around them while being exposed to the emitted organic pollutants. To test for the association between proximity to superfund sites and risk of dementia, this study analyzed data from the Cardiovascular Health Study including geo-tracking software which is able to pair superfund sites with the participants' location. For each of these sites, the specific chemical toxicant was identified (e.g. dioxins) to find which chemical has the most severe impact upon human populations. This study hypothesizes a positive association between proximity to a superfund sites, or number of superfund sites in the area, and higher incidence rates of dementia in the surrounding populations, which will continue to be tested in this ongoing study. If areas with more superfund sites yield a higher prevalence of dementia diagnoses, then the chemicals emitted from superfund sites will need to be studied further to establish an impact upon cognition. Future steps should be taken to investigate the mechanism of this loss in cognition and develop interventions to combat the effects of exposure to environmental toxicants. The goal of collecting information on these pollutants is to inform regulation of superfund sites and their cleanup.

Sophomore Interest Statements

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

Back row (from left to right): Talya Simcox, Abby Torregoza, Riyan Campbell, Askashia Johnson, Jacob Thompson, Nick Pham, Eli Brody, Kyla Zurlage, Tate Bothner

Middle row (from left to right): Sarah Li, Maddie Jaffe, Juni Polansky, Shantika Bhat, Tejal Schwartz, Patience Odeh, Seth Chng-Lim, Tendai Coady

Front row (from left to right): Chielota Uma, Kristiana Smith, Aaron Villahermosa, Julia Alumbro, Maya Filipovitz

Sophomore Interest Statements

Back row (from left to right): Sabina Celnik, Anna Hilger, Nhan Le

Front row (from left to right): Vina Chen, Ihemriorochi Amanze

Not photographed: Isabelle Richard

Sophomore Interest Statements

Investigating the Surface of Mars
Julia Alumbro

My research interest is planetary science, which is the study of planetary systems. The most common planetary system studied in this field is our solar system, and I plan to research Mars. Current research in this field involves tracking dust storms, recording seismic activity, and observing slope forms on Mars' surface. Data from Mars is either obtained from a digital screen or a physical component of the planet itself. In a recent study, dust storms were being observed to find a safe landing area for a future rover hoping to launch in the year 2020. Additionally, more data has been collected on Mars' seismic activity to investigate its interior properties and composition. Lastly, research has been conducted on the slope landforms of Mars to know about its history. Since there is only one rover on Mars, teams of researchers and engineers have planned to send another rover in 2020 which will help us collect data more efficiently. To conduct research in this field, I am pursuing the Ingenuity Research Practicum and hope to find a mentor in the field of astronomy and planetary science.

The Biomedical Engineering of Prosthetics
Ihemriorochi Amanze

I have gained an interest for the field of Biomedical Engineering, which is a field of science dedicated to using machines in the hopes of medically helping and improving people's lives. Prosthetics is a specific branch of that field focusing on using machines to replace and replicate existing limbs of amputees to help them live out their lives as they were before the loss of their limb. Prosthetics have been in use since 950 B.C and have continuously changed and improved through the years. Through multiple methods, such as Targeted Muscle Reinnervation and Bionic Arm Technology, prosthetic technology has continued to prosper and become a fundamental branch of Biomedical Engineering. However, the science of prosthetics has much to learn and improve upon, such as getting prosthetics to take signals straight from the brain to function, and to even take functions from the brain and move the prosthetics at the pace of a biological limb. Hurdles also include making prosthetics that move as fluidly as a human limb, and adding a sense of touch to prosthetics to bring that feeling back to amputees. All these hurdles must first be addressed before making a prosthetic that can be universally known as the best to help amputees, but as time goes on, the science of prosthetics continues to advance and help more people. In the future I will be working more closely on this subject under the guidance of Dr. Jeremy Brown at the Haptics and Medical Robotics (HAMR) lab, at the Johns Hopkins University.

Understanding the Relationship Between Diabetes and Alzheimer's Disease
Shantika Bhat

My research focuses on the relationship between Type 2 diabetes and Alzheimer's Disease (AD). Diabetes has been labeled as a risk factor for AD, so I wanted to explore the reasons why these two diseases have been connected and learn about possible treatments that would help in the prevention of AD onset. AD is a neurodegenerative disease that affects the ability to keep neural cells alive due to oxidative stress, insulin resistance, impaired insulin signaling, inflammation, and mitochondrial dysfunction leading to impaired memory and cognition. Diabetes is caused by high blood sugar, which leads to insulin resistance, inflammation, and many other issues in the body. My research focuses on expanding the research done in studies concerning finding AD treatments and the use of Intranasal insulin. The basis for this research is that when the brain has impaired insulin signaling it leads to neural cell deaths, so the use of insulin could help prevent the development of AD. Multiple studies have examined if intranasal insulin can work, however due to factors like gender, race/ethnicity, and different APOE4 genes, the treatment often has varied results from patient to patient. As a result, more research needs to be done on this treatment and other proposed anti-diabetic treatments in order to help find a treatment for AD. I plan to find a mentor that is working with degenerative neurological diseases such as AD or other neurodegenerative diseases in order to better understand the research needed to be done to help patients with these diseases.

Sophomore Interest Statements

CRISPR-Cas Systems: Applying Old Strategies to New Solutions
Tate Bothner

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) are sequences of DNA that bacteria use to defend against pathogens. CRISPR and CRISPR-associated proteins (Cas) are an adaptive bacterial immune system that works to prevent infection from viruses by storing genetic information from viral attacks. When a new virus infects the bacterial cell, the bacteria uses CRISPR-Cas systems and DNA fragments from previous viral attacks to combat the new virus. My research includes three studies. The first is a study on CdpR, a key regulator for CRISPR-Cas systems, which influences adaptation and interference functions within a cell. Another study highlights the co-evolutionary battle between bacteria and phages, viruses that attack bacteria, and the role that CRISPR-Cas systems have played in this battle. Bacteria have CRISPR-Cas systems that have evolved to attack phages and phages have evolved to have anti-CRISPR proteins that inactivate the CRISPR systems. A third study extends beyond the study of Cas9 to examine the functions of several other Cas proteins including Cas4. Cas4 is an important factor in the "memory" of the CRISPR-Cas system. Currently, the main application of CRISPR-Cas systems is gene editing to improve human health, however, understanding these systems can also help us to better understand bacteria as a whole, their interactions with other organisms, and their role in their environment. I plan to continue with the Ingenuity Research Practicum and will be mentored by Dr. Scott Bailey in the Department of Biochemistry and Molecular Biology at Johns Hopkins Bloomberg School of Public Health.

In-vitro Stem Cell Culturing in Three-dimensional Matrices
Eli Brody

Stem cells are cells that have the ability to differentiate into other types of cells when needed. They are very important for trying to grow tissues and cell colonies outside of an organism. Laboratory cell culture has been done for many years; however, recently, the introduction of three-dimensional culturing environments has revolutionized the efficiency and accuracy of in-vitro culturing. To grow something in-vitro means outside of a living organism. 3D cultures are being used to repair blood vessels, rebuild stroke-damaged neuronal networks, and heal skin wounds. These matrices also assist in in-vitro stem cell differentiation, such as building blood vessel networks from stem cells. This involves creating a culturing environment that influences the stem cells into turning into blood cells which then grow into networks. Another benefit to three-dimensional culturing matrices is their ability to support flow of fluids such as blood or interstitial fluid. Flow of fluids creates more realistic cultures as cells respond to flow through differentiation and metabolic adaptation, meaning they can be manipulated simply by adding flow of fluids through the environment. Finally, 3D cultures can better support developing differentiated cells, as it is easier to regulate nutrient contents and various other factors. Soon, biomedical engineers will be able to grow whole tissues and organs in-vitro. This could allow for transplants to humans without needing a donor. As I pursue Ingenuity Research Practicum, I hope to find a mentor in the Department of Biomedical Engineering at Johns Hopkins University.

The Dormancy of Cancer Cells
Riyan Cambell

I am interested in the field of dormant cancer cells that cause mutations and how they relate to cancer metastasis. Dormancy is a stage in cancer progression where the cells cease division but survive in a quiescent state while waiting for the right environmental conditions to begin proliferation again. The first study shows that solitary, dormant human cancer cells, retrieved from metastasis-free organs of animals carrying ad lib biological process primary tumors, can activate their tumorigenic and biological process potency. The tumors were created by MDA-MB-435 CL16 malignant neoplastic disease cells. The second study reviewed the molecular mechanisms of dormant-related cancer cells, with an emphasis on the cross talk between cancer cells and their microenvironments. However, current data in this field are restricted. The third study proves how bone marrows stromal macrophages, through exosomes, regulate the behavior of breast cancer cells, by either increasing or reversing dormancy. By doing this research, scientists can now have more clarity as to how mutations operate when it comes to cancer. The research shown in this poster display can open doors for new solutions in chemotherapy. I plan on pursuing Ingenuity Research at University of Maryland under Dr. Michelle Vitolo in a lab alongside Dr. Stuart Martin. Mrs. Vitolo.

Sophomore Interest Statements

Learning Processes and Memory Systems in Octopuses
Sabina Celnik

Neuroscience is the study of the function and processes of the brain and nervous system. My research is focused on the neuroscience behind the learning and memory systems in octopuses. The studies I explored looked at the ways these complex systems function in octopuses and how these processes lead to octopuses incredible intelligence. One study focused on exploring the vertical lobe (VL) system in octopuses and which aspects of learning and memory the VL system controls. Another study examined the way in which octopuses identify whether or not an octopus tentacle is their own. Octopuses are not aware of their arms and their suckers attach to everything they come in contact with, so being able to identify if a tentacle is their own or not is extremely important to ensure they do not accidentally eat themselves. A third study looked at the neural circuits that control the skin papillary muscles that are used for long-term camouflage. Octopuses and cuttlefish are able to modify their skin texture and color in order to camouflage perfectly into their environment, which allows them to avoid predators. Finally, I reviewed an article linking octopus genetics to human genetics through their neural mechanisms. Proving that human neural mechanisms are similar to octopus neural mechanisms verifies the importance of conducting research on octopuses, because through that, we can learn more about the human brain and our ancestors. I plan to continue with the Research Practicum at Johns Hopkins under Dr. Gul Dolen who works in the Solomon H. Synder Department of Neuroscience researching connections between octopus and human brains through their neural mechanisms.

Tissue Engineering: Methods and Materials
Seth Chng-lim

I am interested in the study of tissue engineering, which is a branch of engineering that involves the use of cells and biomaterials to improve or replace existing tissue. Specifically, I would like to focus on the scaffolds used in tissue engineering. Scaffolds are the "frames" for scientists and surgeons to grow new organs and tissues after getting cells from a donor or a patient. Tissue engineering is important because it can change lives and can create new boundaries and things to be explored. It can change lives because it might be able to completely replace broken or worn down organs with new and improved ones, and this ability would be able to greatly increase the lifespan of humans. I have read a few of articles about this topic and learned how scaffolding works, and about a new method of tissue engineering that utilizes sound waves instead of scaffolds. With this knowledge, I plan on continuing with the Ingenuity Research Practicum. I hope to find a mentor in the Biomedical Engineering Department at Johns Hopkins School of Medicine.

Single-Molecule Biophysics
Tendai Coady

Single-molecular biophysics is the study of the physical properties of biological molecules through individual analysis. This involves one of several methods of visualizing, tracking, and physically manipulating molecules, which may include fluorescent probing, atomic force microscopy, and optical trapping. This can help researchers understand molecular properties such as structure, shape, and size with a higher precision than other techniques. One example of current research in this field is shown in a 2018 study, in which researchers examined Cas9 using FRET. These researchers found that engineered Cas9 was more precise than wildtype Cas9, because it sought out one extra base pair as a threshold for cleavage. In another recent study, researchers found using fluorescence resonance energy transfer (FRET) that spider silk peptides behaved in a similar manner to linear springs, which the researchers suggested could be used to potentially test for force and tension in molecules. A final recent instance in which researchers used single-molecule biophysics was in a study where an interaction between DNA and an organic molecule called putrescene was caused and documented, revealing that the reaction neutralized the phosphate backbone of DNA. Future work in this field could involve practical incorporation of single- molecule biophysics in vivo. I hope to be working in biophysics, biochemistry, or genetics for Ingenuity Research Practicum.

Sophomore Interest Statements

Environmental Impacts of Natural Gas Emissions
Maya Filipovitz

My research field of interest is natural gas emissions and their environmental impacts. These emissions, from the coal, oil, and natural gas industries, all leak harmful substances into the air. Therefore, it is vital to know how much damage is being done from these emissions and how that will further impact the Earth. Current studies have explored the type and amount of emissions that are being released by the oil, coal, and natural gas industries. Another current study is finding how the Earth will be impacted from climate change. We already know that natural gas sources and sinks will be altered, but to what extent is unknown. Finally, data is currently being gathered using large satellites to reach an estimation of the magnitude of emissions from all around the world. Since our lives are based on the success of our planet, it is vital that we know how much damage is being done from all of these emissions and how that will further impact the Earth. Hopefully, this research will help inform public policies, which may apply restrictions and regulations on harmful emissions. I will continue with the Ingenuity Research Practicum and will be mentored by Dr. Andrew Gordus in the Department of Biology at Johns Hopkins Krieger School of Arts and Sciences.

Understanding Food Scarcity in Critical ZonesTthrough Old and New Methods
Anna Hilger

Currently, the food science industry is down many pathways. My project is focused on its discoveries involving food security near high-poverty, critical zones. So far, my research has explored various topics including an examination of the protein found in bugs, ways to limit our dependence on the phosphorus cycle, and the history and variables that contributes to soil degradation. My research will be an overview of the most prominent and effective modes of fighting against food scarcity. This information will hopefully educate others that food scarcity is a reality of today; it may not impact us directly, but at the global level, it is a reality for four billion people. Future work in this field includes furthering studies in getting our society less dependent on nonrenewable resources such as phosphorus through possibly genetically modifying plants, exploring more methods in powdered supplements for the present issue of food scarcity, and finding a means of obtaining necessary nutrients. I would like to work with a food science lab and focus more on the supplemental part of the solution. I am currently looking into private food corporations for a possible mentoring location.

The Human Impact on Horseshoe Crab Populations
Maddie Jaffe

My research field of interest is marine biology/ecology. This is the study of aquatic habitats and the creatures who primarily dwell in them. Currently, much of marine biology is dedicated to the conservation of marine creatures and ecosystems, as they are threatened by many human-caused problems such as climate change, habitat loss, and overfishing. One native species found in Maryland is the horseshoe crab, which faces many of these threats. Current research focuses on how horseshoe crab population levels are falling drastically due to overharvesting. Other studies focus on their usefulness to the biomedical field: horseshoe crab blood is naturally capable of detecting endotoxins, making it valuable for finding disease-causing bacteria in humans. One last example of current research is how climate change affects horseshoe crab habitats, such as the Chesapeake Bay. Studies have linked climate change to warming waters that both encourage the rapid reproduction of harmful pathogens and worsen horseshoe crab breeding conditions. These lines of research help us understand how humans impact the horseshoe crab, often described as a keystone species in many ecosystems. This may impact efforts to preserve a healthy, biodiverse Chesapeake Bay, sustain the fishing industry, and contribute to better human health. When I continue with the Ingenuity Research Practicum next year, I will be working with Dr. Eric Schott at the Institute of Marine and Environmental Technology (IMET) to monitor biodiversity in Baltimore's Harbor. From there, I would like to continue my own research in further increasing biodiversity and decreasing pollution in Maryland waters.

Sophomore Interest Statements

What is Schizophrenia and How Does it Affect the Body?
Akashia Johnson

There are many psychological disorders which affect mood, thinking, and behavior. Schizophrenia affects a person's ability to think, feel, and behave clearly. In most articles it clearly stated that there is no cure for schizophrenia. This is a disorder that causes damage to tissues in the brain and can cause death. People with the disorder usually has a lifespan that is shorter by 15-20 years. Volume changes of schizophrenic brains are caused by the lack of developed cell bodies. Gathering research and understanding this disorder can help find a cure. Previous research has shed a lot of light on how people diagnosed with schizophrenia might be helped, such as making a daily routine to follow. Researchers also found some triggers of schizophrenia, as well as how eating well and exercising might help treat the disease. Researchers contributed a lot of useful information including finding a type of magnetic resonance imaging that helped people who believed they were dying from schizophrenia but were actually losing their brain tissue because of the lack of dopamine. Studies show that in the future dopamine may be a cure or the best treatment that can help the patients stay stabilized. However, many questions remain. I would like to study psychological/neurological sciences, which focus on studies of brain disorders that affect bodily functions.

Zebrafish Heart Regeneration
Nhan Le

Physiology is a branch of biology that deals with the structure and functions of living organisms and their parts. The research I am focusing on involves zebrafish and their heart's ability to regenerate. Current research in this area focuses on identifying the factors that trigger heart regeneration, and those which signal completion of the process. Other current research includes studying ways to use the information on zebrafish heart regeneration in order to develop a treatment for certain heart diseases. There is also research being conducted on how plasticity, the ability of cells to alter, affect heart regeneration. This research is significant as the leading cause of death in the United States is cardiovascular disease, and studying ways to trigger heart regeneration in humans would greatly aid in the effort to develop treatments for cardiovascular diseases. Through the Ingenuity Research Practicum, I will be working in the Department of Embryology at the Carnegie Institution for Science, under Dr. Steve Farber and Maggie Shen in order to research zebrafish metabolism.

Nanostructured Systems in Improving Cancer and HIV Treatment
Sarah Li

Nanoparticles used as drug delivery vehicles are generally of intermediate size between microscopic and molecular structures in at least one dimension and consist of different biodegradable materials such as natural or synthetic polymers, lipids, or metals. Nanotechnology has made it possible to achieve improved delivery of poorly water-soluble drugs, targeted delivery of drugs to specific cells or tissues, and intracellular delivery of macromolecules. A study looked at recent developments of nanotechnology in drug delivery. This study examined the interactions of nanomaterials with the biological environment to further understand how efficient drug delivery could be attained in cancer treatment. Another recent study identified challenges in the current treatment of HIV/AIDS and discussed the potential of nanotechnology to provide more effective treatment and prevention for HIV/AIDS through advancing antiretroviral therapy, gene therapy, and vaccinology. The last study I looked at also reviewed the current challenges in HIV treatment. The study examined how to leverage the unique performance of nanostructured systems in therapeutic delivery for improved treatment and prevention of HIV. Nanostructured systems have tremendous potential to improve targeted drug delivery to viral reservoirs, reduce drug toxicity, and increase dosing interims, thereby improving treatment outcomes for diseases like HIV. I plan to continue with the Ingenuity Research Practicum and I am currently searching for a mentor in the Biochemistry and Molecular Biology Department or Chemical and Biomolecular Engineering Department at Johns Hopkins.

Sophomore Interest Statements

Anesthesia and the Effects on Neurodevelopment in Children and the Elderly
Patience Odeh

My research is focused on anesthesia and the effects it has on infants and children's brain development, as well as cognitive deficits in the elderly population. Anesthesiology is the medical specialty concerned with the total perioperative care of patients before, during, and after surgery. Anesthesia is an important facilitator of a surgical procedure, however scientists have discovered that it might have a negative effect on the brain development of children and cause long-term brain injury. One research study I examined was the PANDA study (Pediatric Anesthesia and NeuroDevelopment Assessment), which assessed 105 healthy children who had undergone inguinal hernia repair, with a resulting drop in IQ scores and changed behaviors. This study conveys the fact that it is very likely that exposure to anesthesia at a young age can affect some domains and neurological functions in the brain. Another study used a mouse model to analyze the various effects that anesthesia had on the brain. In the study, scientists tested whether aging emerges from general anesthesia, because it increases brain sensitivity to the anesthetic drugs. Scientists concluded that aging causes delayed emergence from general anesthetic in rats. Going through a surgical procedure already takes a toll on the patients' bodily functions and the brain is a very important organ in the body. Patients and their families, young and old, should not have to worry about dealing with brain and cognitive deficits. I plan on continuing with the Ingenuity Research Practicum and finding a mentor in Anesthetics or Neurology.

The Urban Water Cycle
Nicholas Pham

My research is focused around wastewater, the excess water released after any type of human use. Wastewater creates many problems on a global scale because it leads to drinking water contamination. One study I found dealt with monitoring the drinking water quality in the city of Ahmedabad, India. Researchers found that almost all parts of the city were affected by contaminated drinking water, especially during monsoon season when flooding can carry irrigation wastewater from farms. In order to research wastewater in the urban water cycle, scientists need to be able to see it. A second study looked at 3D modeling of the city of Odense, Denmark sewer systems. It accurately models aquifers/ aquitards, manmade infrastructure, and hydraulic systems. Many researchers have been trying to use wastewater in productive ways. A third study focused on the potentials of wastewater as a source of energy. The nutrients found inside of agricultural wastewater can be turned into methane gas, which is a common biofuel source. Something in the United States that is often taken for granted is access to clean drinking water. However, across the world, lack of proper sanitation directly affects 2.4 billion people, and leads to 800,000 premature deaths each year. I will be working with Dr. Carsten Prasse from the Bloomberg School of Public Health, who deals with identifying the occurrence and effects of organic chemicals on water quality. I want to delve deeper into the chemistry behind water contamination and its effects on the world.

The Application of Stem Cells in Regenerative Medicine
Juni Polansky

My research deals with cell biology, specifically stem cells, which are undifferentiated somatic cells with the potential to be induced into specific functioning cells. The three studies I looked at focused on different aspects of stem cells. One study dealt with the relationship between stem cells and their cellular environment called a niche. This niche is vital for regulating stem cell survival and functioning. The niche is influenced by Integrin, an endoplasmic reticulum-resident membrane protein complex (EMC protein) responsible for regulating stem cell function, migration, proliferation, survival, and differentiation. Another study found that certain cellular elements in the niche, such as macrophages, are detrimental to the development and function of stem cells. A third study about the efficiency of stem cells as a medical treatment found them to be a better method to treat pediatric central nervous system (CNS) tumor patients due to that fact that they reduced the hospital stay and antibiotic exposure without increasing risk. Stem cells are important in the field of regenerative medicine, because optimizing stem cells could create treatments for life threatening diseases such as cancer. This field is expanding rapidly as more uses for stem cells are being discovered and tested. Due to stem cells' pluripotent capabilities, results from studying this field have wide reaching impacts, from people with cancer to people with minor burn damage. As of now I do not have a laboratory placement, but I am hoping to secure a place at a lab at Johns Hopkins Homewood campus that deals with cells and their biology.

Sophomore Interest Statements

The Upcoming Wave of Psychedelic Research
Isabelle Richard

The field of research I am pursuing is psychedelic drug research. Psychedelics are a type of drug which alter state of consciousness, as well as visual/auditory and thought reception. I am interested in research which explores the therapeutic use of such drugs for mental disorders, such as depression, anxiety, and PTSD. One current study was an experiment about the effect of N,N-Dimethyltryptamine (DMT) on mood and anxiety in rodents. This study showed that a low dosage of the drug improved mood and anxiety in the test subjects. Another study conducted displays that psilocybin enhances sensory cortical activation in response to memory cues, implying that psilocybin enhances memory. More research being done expresses that psilocybin is extremely effective in the handling of treatment-resistant depression, furthering its implications for other therapeutic purposes. To find out more about the relatively new and undiscovered field I plan on continuing with the Ingenuity Research Practicum and will be mentored by Dr. Ana Maria Rule in the Department of Environmental Health and Engineering at Johns Hopkins Bloomberg School of Public Health.

Organ Transplant Immunology: How to Make Organ Transplants Last
Tejal Schwartz

Organ transplant immunology involves researching ways to limit the body's immune system rejection response when it identifies allograft tissue as foreign and a threat to the body, and to help patients who must undergo heavy therapy of immunosuppressive drugs in order to combat this rejection. The first study I encountered was aimed to induce operational tolerance without immunosuppressive therapy by using a T-cell based therapy in living donor liver transplantation (LDLT). The conclusion was that Treg-enriched cell therapy is a promising method to minimize administration of immunosuppressive drugs and to induce operational tolerance in patients undergoing LDLT for non-immunological liver diseases. Another study investigated how different gut microbes in mice contributed to varied outcomes in solid organ transplant. Results showed that gut microbes could be a potential therapy method to prolong allograft survival. A third study involved researchers sequencing donor-specific Tregs before transplant and tracking them after transplant in combined kidney and bone marrow transplantation (CKBMT) recipients. Their results suggested that early expansion of donor-specific Tregs induces tolerance following CKBMT. The ongoing research in this field is extremely important and necessary for improving the lives of people who are battling all types of immune rejection to new tissue following transplantation. As of now, I am pursuing the Ingenuity Research Practicum by attempting to identify a mentor in this field of organ transplantation and immunology, preferably one stationed at Johns Hopkins School of Medicine.

LevelCheck: An Intraoperative Tool Assisting Spinal Surgeons
Talya Simcox

Biomedical engineering combines engineering, biology, and medicine. The primary research in this field is the development of medical devices including creation of artificial organs, and machines for diagnosing medical problems. The first study focused on the amount of wrong-level spine surgeries and the probable cause behind them, and therefore showed the dire need for a solution. Another experiment I looked at used X-Ray images to better see the spine during surgery to decrease surgical complications. From this experiment, which was comprised of 50,000 trials, only one failed with complications due to the machine not working. The third study showed that the programming LevelCheck would be able to accurately label the vertebrae and be able to better identify the problem during surgery and to address any complications. From these studies, we can gather that using the 3D imaging programming system, LevelCheck, can accurately and efficiently label vertebrae and give a clear vision of the spine during surgery, thus improving the chance of success to about 99.998% accuracy. The progress between these studies shows the development to what ultrasound-guided spine surgery is today. I will be continuing with the Research Practicum and am looking for a mentor in my field of interest, biomedical engineering.

Sophomore Interest Statements

Mechanisms and Consequences of Chromosome Missegregation
Kristiana Smith

Many of the organisms found on our planet, including humans, rely on mitosis to maintain life and produce healthy, functioning cells. I have an interest in exploring how errors during mitosis may contribute to the development of adverse molecular consequences, such as the formation of micronuclei and the development of tumors. In one study, researchers established that the presence of specific proteins greatly impacts the rate at which micronuclei are formed within a cell. These proteins are Polo-like kinase 1 (PLK1) and Cyclin-dependent kinase 1 (CDK1), which play important roles in preventing Nuclear Pore Complexes (NPCs) from enveloping lagging chromatin. Other researchers found that specific patterns of aneuploidy and chromosome missegregation are found in certain types of cancers and tumors. Finally, a third study observed that within cells with high rates of micronuclei formation the cells tend to more frequently undergo cell death and apoptosis. It is theorized that understanding the mechanisms surrounding the development of micronuclei will further our understanding of tumorigenesis, as the presence of micronuclei and chromosome instability are prominent hallmarks of solid tumors. Based on my interests, I am seeking out a mentor in the John Hopkins University School of Medicine's Department of Molecular Biology and Genetics or Department of Cell Biology.

STI Epidemiology
Agnes Torregoza

Epidemiology is the study of the distribution and management of health conditions and diseases. My research is focused particularly on preventing the spread of HIV and sexually transmitted infections (STI). Demographics can be observed in STI surveillance data to determine which populations are in need of intervention. A recent study on syphilis control found that populations that may especially benefit from outreach include MSM (men who have sex with men) and people who are transgender. Another study analyzed epidemiological and demographic data of HIV/AIDS in the Deep South, which is the most affected by this epidemic in the United States. It could be explained that the cause of this is due to social stigma and high levels of poverty and uninsured people, which leads to overall poor health. The final study I observed tested to see how chlamydia and gonorrhea affects HIV-infected pregnant women and their infants. Of all the infants observed, 40% had adverse outcomes. It is necessary to control these infections to promote the general wellbeing of public health. I would like to study STI epidemiology and effective intervention in Baltimore City under the mentorship of Dr. Jacky Jennings, who is at Johns Hopkins Bloomberg School of Public Health.

Greenhouse Gas Emissions
Jacob Thompson

My research focuses on greenhouse gas emissions from natural and anthropogenic sources, as well as their global impact on climate and temperature. The majority of the articles I found regarded the emissions of methane from anthropogenic and natural sources across the world. One study looked at the extraction of natural gas from shale formations, during which a large amount of methane escapes due to leaks or venting, meaning shale gas has a high greenhouse gas footprint and does not provide a good alternative to oil and coal. The next study concerned how carbon trapped in permafrost could possibly be released in the near future due to increased thawing as a result of higher global temperatures. Wetlands in the Russian Arctic alone could release an additional 6-8 megatons annually as a result of this. This study provided an interesting point of view on how higher global temperatures can perpetuate warming as they lead to increased release of methane from permafrost, raising the global temperature. The final study looked at reducing anthropogenic emissions in order to mitigate rising natural emissions. The study showed that even in the case of uncontrolled methane emissions from the Arctic, a significant reduction in anthropogenic emissions would easily outweigh it. The mitigation of both anthropogenic as well as natural greenhouse gas emissions, especially methane, is essential for limiting the enormous global climate change seen in recent years. In pursuing Ingenuity Research, I intend on working with Dr. Emmy Smith in the Department of Earth and Planetary Sciences at Johns Hopkins University.

Sophomore Interest Statements

Finding the Best Treatment for Phantom Limb Pain
Chielota Uma

Phantom limb pain is a type of neurological anomaly that can cause amputees to feel excruciating pain in a limb that is no longer there. The proper treatment for amputees experiencing phantom limb pain must be both affordable and effective, regardless of their baseline level of pain, or whether or not they are bilateral amputees or unilateral amputees. I am interested in finding the most effective treatment for these amputees, as addressed in one study which explored computer imaging and how it compares to mirror therapy (a popular, generally short-term method of treatment). Two more studies looked at the proposed reasoning behind phantom pain and how a traditional method of treatment holds up against it. The current project will help people understand more about a terrible condition that plagues the lives of many amputees daily, and help raise more awareness. I will be mentored by Dr. Pablo Ariel Celnik, who works at Johns Hopkins Hospital and works with people who are suffering from maladaptive plasticity due to trauma in the nervous system/brain.

Martian Habitability and Exploration
Aaron Villahermosa

For my research, I have decided to explore planetary science with a focus on Mars, something that I have always had a love for since childhood. Mars has been on the forefront of planetary science ever since we gained the technology to properly study planets other than our own. People have often fantasized about new, different lifeforms being present on Mars, which is evident in the numerous sci-fi works that have life on close and distant planets. However, those sci-fi works of fiction may not be as far-fetched as most people would believe. One current study has examined slope streaks, a surface feature that is present in Mars. Scientists believe that slope streaks are formed by transient subsurface water activity, which is important because living things need water to survive. Because of this discovery, scientists now acknowledge the possibility of life on Mars. Another study looked at the possibility of using Martian soil as building material, and yet another focuses on the best landing spot on Mars. This is significant, because one day we humans may be able to set foot on Mars and understand more about the world around us. I plan to continue with the Ingenuity Research Practicum and find a mentor in planetary science that focuses mainly on Mars.

Computational Biology's Application to Cancer Genomics
Kyla Zurlage

In order to understand the genetics behind cancer, computational biology, a field that uses computer algorithms and math to understand biological systems, is used to give meaning to vast amounts of seemingly unmeaningful data. Part of the current research in this field involves developing and testing various methods for genomic analysis. One research article found that the use of multiple computational genomic methods was successful and dependable for the study of gastric cancer. In another article, researchers attempted to use computational approaches to gather new information about the different subtypes of ovarian cancer. This research was inconclusive. However, a simultaneous analysis of both genomic and epigenomic data provided significant insight into learning more about cancer. A third experiment found that a Python-based algorithm, called Pathoman, was a dependable method of analysis of cancer, however it should not be used independently of other methods since it is not yet completely accurate. This research provides a better understanding of cancer, which will lead to advancements in treatment plans, prevention, and early diagnosis that are incredibly necessary today in a world where cancer is so prevalent. I will be continuing with the Research Practicum and will work with Dr. Wheelan from the Bloomberg School of Public Health who studies genomic sequencing.

Innovation Interest Statements

Ingenuity Innovation Practicum is a new pathway within The Ingenuity Project. The Innovation Practicum is a one year experience during junior year and a portion of summer that provides Ingenuity students with an out-of-school experience in the field of data science, statistics, and applied mathematics. Using mathematical software and receiving mentorship from a participating business/organization, students will learn about data analytics and problem -solving as it relates to mathematics and real data analysis.

Back row (from left to right): Alejandro Barrera, Frank Tagaytay, Michael Aladejebi, Obafemi Anjorin, William Kardas

Front row (from left to right): Lucinda Borhash, Chelsea Thompson, Isaiah Chapman, Peter Filardi, Lucy Canick

Innovation Interest Statements

Back row (from left to right): Tahdai Crews-Harris, Stephanie Fishkin, Simon Spahn-Rodrquez

Front row (from left to right): Jennifer Zheng, Ana Basoco

Innovation Interest Statements

Statistics of Abandoned Houses in Baltimore
Michael Aladejebi and Obafemi Anjorin

Our research is about statistics and how it can help solve real world problems. Specifically, our research explores the statistics of vacant houses in Baltimore from past years. Various studies show how poverty can affect the amount of vacant houses in cities, and how climate in certain places can affect old houses as well. We will use statistical analysis to understand how other factors affect vacancy rates and what could be done to help it. This research really affects our lives because it is a way to help the people. Baltimore and create more places to live and a better economy overall. Obafemi Anjorin will explore a research path over the summer. Michael Aladejebi wants to learn more about applied mathematics by joining the Mathematical Institute for Data Science (M.I.N.D.S.) at Johns Hopkins University, which specializes in field of data science.

Applications of AI
Alejandro Barrera and Ana Basoco

The topic we are interested is Artificial Intelligence (AI). We would like to learn how AI can be applied in various situations to either make life easier or to simply act as entertainment. To better understand AI, we focused on how machine learning is used to master strategy based games, like chess, or games like Mario, in which the player must learn game mechanics. In the future, AI can be used for a multitude of things, such as solving problems and executing tasks more efficiently than humans. In one study, researchers looked into how robots can learn actions through human demonstrations, and what their outcomes are. The robot had a variety of expressions tested and could adapt the human demonstration of the activity to fit their needs, such as picking up a phone or washing the windows. As a result, the robots would then either emulate or imitate the human's action. AI can be used for things like facial recognition (which is already being experimented with), aiding humans in endeavors like education by helping them recognize patterns that can optimize an individual's learning, and learning and identifying phases of matter as studied in machine learning phases of matter. Another research study examined how machine learning can classify and characterize different data sets to identify states of matter in physics. In the form of neural networks, AI can also predict where aftershocks of an earthquake will be and possibly the size of the aftershock. We hope to find a placement that will offer us the opportunity to learn more about AI and machine learning.

Using Mathematics to Model the Bread Baking Process
Lucinda Borbash and Lucy Canick

Bread has been around since nearly the beginning of time. It was so valuable during select eras in history that it was used as currency. Baking bread is not easy; there are many things that must be taken into account when making it, and many things that can go wrong during the making of it. Numerous studies have been conducted concerning bread and the change and development of its properties before, during, and after baking. One such study focused on the makeup of flour used to bake bread and how the sugar content affected dough viscosity and bubble size in the end product. Another study evaluated the difference in effect the baking of the bread has on the crust and the crumb (inside). One more study calculated a mathematical model to depict and predict heat and mass transfer in bread; it is a nonlinear model, one which factors in all the different ways bread is heated during baking. The research shown in the poster all points towards the notion that different properties of bread can be achieved without trial and error, but instead with mathematical consideration of the effects each factor of the bread's baking has on the end product. This may not seem significant, but if bakers are able to formulate ideal quantities or ratios of ingredients, it reduces their experimentation and therefore reduces all the waste that comes with said experimentation. Our Innovation Practicum placement is in the applied mathematics lab of Towson University, where we hope to be practicing with problems concerning actuarial science and other similar topics. This project is helping us get there by giving us experience thinking about everyday situations in terms of mathematics.

Innovation Interest Statements

The Connection Between Humans and Computers
Isaiah Chapman

The topic of Human-Computer Interaction is the focus of my research. Human-Computer Interaction is the interaction between humans and technology. One research study reveals that product functionality and performance is not the only important factor in product quality. Another important factor is the way users feel towards the product. If a product works but users do not understand the product or feel comfortable using it then the product's value is diminished. Another current study explores the frustration of people using social media automated personalized recommendations. Hidden algorithms within software, such as Instagram and Facebook, are the cause of this frustration. A third research article explores recommendation systems. The systems are complex and consume large amounts of data, such as likes and comments on a post. These systems have difficulties relating data collected over a long period of time. Human-Computer Interaction is an important topic to study because technology is a continuously growing part of our society. New technology should enhance efficiency but can be enjoyable. I plan to continue with the Ingenuity Innovation Practicum at Morgan State University in the Department of Mathematics. This would be an opportunity to study how applied mathematics algorithms and problem-solving can be used to change the way people develop computer algorithms.

The Use of Mapping and Cartography in Science
Peter Filardi and William Kardas

Our topic of interest is cartography and the use of maps in science. Mapping is an important tool scientists use to track changes in social, economic, or geographic features. The research we are studying is important for scientists to understand before conducting a study. One article we read was about the frequency of storefront windows in Portland, Oregon. The study tracked how the number of storefront windows in a region correlated to that region's economic prosperity over time. Another study is about mapping the structure of urban areas. The study measured the size and shape of urban structures, allowing for the recording of data about the urbanization of areas over time. A third study was about comparing geographic shifts in urban areas. It used satellites to track the urbanization of areas. Mapping is so important because it is a way of recording information that is easy to understand and read, even if you have little knowledge about what you're looking at. With proper mapping anyone can understand complex ideas. We are currently looking for a mentor as we pursue the Innovation Practicum.

Applied Mathematics and Neighborhood Poverty
Stephanie Fishkin, John Djeuf, and Tahdai Crews-Harris

Our research involves the use of applied mathematics, statistics, and sociology. We are focused on the statistical relationship between neighborhood poverty and childhood academic achievement/behavioral problems. Our research explores a longitudinal study that compares the family, school, and neighborhood characteristics of African American and Latino children living in impoverished neighborhoods of Chicago. This study also provides evidence to support the association of food insecurity with internalized/externalized behavioral problems among Chicago youth. Lastly, we analyzed a study regarding community violence and crime rates in Baltimore and the effect on elementary public school students' academic achievement /perceived safety. This research is significant as it provides evidence in support that specific demographics are more disadvantaged to begin with. Future work in this field could investigate the ways to mitigate social settings to provide more positive behavioral/academic outcomes in a child's future. Tahdai Crews-Harris will be pursuing Senior Research Practicum and is interested in applying mathematical concepts to solve real world problems. John Djeuf will be participating in a summer research option and hopes to learn more about statistical language. Finally, Stephanie Fishkin will be pursuing the Innovation Practicum and will be mentored by Ms. Anne Claggett at Traitify. She is interested in using mathematical concepts to research sociological issues such as behavior and job performance.

Innovation Interest Statements

Income of Insurance Companies
Simon Spahn-Rodriguez

I am interested in conducting research to understand how insurance companies (more specifically auto insurance companies) make money. Many people believe that these companies make money off of premiums alone. However, the process is a lot more complicated. Insurance companies take a great deal of information into account when calculating premiums. For auto insurance companies, factors such as location, car model, and accident history play a key role in calculating a variable called managed risk. After taking the managed risk into account, insurance companies will still generally charge more than they expect to pay out. Despite this, it is not uncommon for an insurance company to pay-out more money than they make in premiums, and because of this an alternative method of income is necessary. In order to achieve this, these companies will make investments into stocks and bonds. In order to ensure that a profit is made off of these investments the companies will invest in low risk areas. Organizations such as the Insurance Information Institute have done research into where these companies should invest. In order to continue research into the field of risk management I am hoping to work with a professor at the Mathematical Institute for Data Science (M.I.N.D.S.) at Johns Hopkins University, which specializes in field of data science.

Improving Analysis Through Optimizing Network Flow
Frank Tagaytay

How can we improve our analysis and processing through an improved network flow? In the modern world network and data analysis are more important than ever. Software engineers have already found ingenious ways to achieve network flow. One study looked at how we can optimize sampling through a sliding window model. This same sliding windows concept can be applied to data streams with hard constraints. As explained in another study, we can see that by breaking apart a data stream into smaller parts it takes less bandwidth to read the data stream. This decrease in use of bandwidth can allocate space for further processing. The extra space can prove important to a large data set analysis. My research will deal with optimizing network flow and allow for faster processing. I will pursue the Innovation Practicum and will be mentored by Mr. James Dolgin, the Director of Product Development at Dipole Materials Inc., located at Habor Designs.

The Five Factor Model and Statistics
Chelsea Thompson and Logan Samuel

The five-factor model is used in research to evaluate personality. The five factors of this model (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) are measured on a continuum. This makes it easy for this concept to be applied to statistics. Researchers often use personality tests to measure these traits, then use statistics to calculate and predict job performance. Employers are able to give their prospective employees these tests in order to evaluate performance and traits, then apply these data when hiring. This information can also be used to find job placements. Rather than being evaluated for one job, subjects are recommended for jobs that other people with similar traits perform well in. Research in this area provides people with jobs they are more likely to enjoy, which can decrease stress levels. Another way the five-factor model is used in research is to predict mental illness by comparing common traits. One way this concept can possibly be applied is to education (college) in order to determine if certain fields will be of interest to particular individuals who may think they are interested in a field but may later find that they dislike it. Moving forward, Chelsea Thompson will pursue the Innovation Practicum while working under Ms. Anne Claggett at Traitify, where the five-factor model is utilized in similar ways. Logan Samuel will not be pursuing research under the Ingenuity Project but plans to pursue research on psychology elsewhere.

Innovation Interest Statements

Stock Analysis and Business Evaluation
Jennifer Zheng

Stock analysis is the process of observing stocks to identify trends, determine future performance, and predict the most likely gains or losses. An improvement in the stock market indicates the economy is doing well, investors are getting back what they put into the company, and the company's performance is improving. During my initial research, I discovered three current studies, each relating to a specific part of stock analysis and business evaluation: 1.) "What are effective strategies for businesses and how should these strategies be implemented?"; 2.) "How does stock overreaction impact an area?"; 3.) "The best model for analyzing stocks is the MSVR (modified support vector regression) model?" In each source, it is respectively determined that for a business to perform well, the company has to be able to find and implement effective strategies to excel. Stock overreaction impacts areas with high volatility the most, and the MSVR model predicts the future performance of stocks the best. These studies can be used to improve the performance of a company and better help people predict the performance of stocks which in turn can improve the stock market, the economy, and the residents' financial conditions. I am aiming to work with professors at the Mathematical Institute for Data Science (M.I.N.D.S.) at Johns Hopkins University. M.I.N.D.S. consists of individuals specializing in mathematics, statistics, computer science, and engineering that work together to develop the principles in order to analyze and interpret high-dimensional data.

Class of 2019: College Acceptances

* denotes the college /university the senior will be attending

Sumaita Ahmed
Morgan State University – Honors Program
University of Maryland, Baltimore County*

Ayden Allston
The College of Saint Rose
Occidental College
University of Maryland, College Park (College Park Scholar)*
University of South Carolina

Nathaniel Alper
Brown University
Columbia University*
Georgetown University
Northeastern University (Honors)
University of Maryland, College Park (Honors, Banneker Key Scholar)

Erika Anderson
University of Maryland, College Park (Honors)
University of Miami
University of Michigan (Honors)*

Amanda Berry
Lehigh University
University of Maryland, Baltimore County
Vassar College*

Taylor Booker-Godfrey
George Mason University
James Madison University
Pennsylvania State University
University of Maryland at College Park (Scholar)*

Matias Calderon
Pennsylvania State University
University of Maryland, College Park (FIRE)*

Keara Caverly
Boston College
Pennsylvania State University
University of Pittsburgh
University of Rochester
Villanova University (Honors)*

Chelsea Cole
Salisbury University
Towson University*
University of Maryland, Baltimore County
University of Maryland, College Park

Lily DeBell
California Institute of Technology*
Emory University
Loyola University of Chicago
McGill University
University of California, Berkeley
University of Maryland, College Park (Honors)
University of Michigan
University of Pennsylvania
University of Washington

Brandon Dillow
Johns Hopkins University (Baltimore Scholar)*

Evains Francois
Johns Hopkins University (Baltimore Scholar)
Northwestern University*
University of California, San Diego
University of Maryland, College Park (Honors) – Banneker Key Scholar

Karen Griffin
Haverford College
University of Maryland, Baltimore County (Meyerhoff Scholar)*
Williams College

Corbett Glaros
Drexel University
George Washington University*
Pennsylvania State University
St. John's University
Syracuse University
Temple University
University of Maryland, College Park (BioFIRE)

Lily Goldsmith
Bard College
Maryland Institute College of Art
The New School (Joint BA-MA Program)
Pennsylvania Academy of the Fine Arts
School of the Art Institute of Chicago
St. Mary's College of Maryland
University of Maryland, College Park (College Park Scholars)*

Class of 2019: College Acceptances

John Halpin
Georgetown University*
University of Maryland, College Park (Honors)

Samuel Harkness
University of Maryland, Baltimore County (Honors)*
University of Maryland, College Park (College Park Scholars)

Ula Holland:
Pacific Northwest College of Art
The American Academy of Dramatic Arts
Towson University
University of Maryland, College Park
Virginia Commonwealth University, School of the Arts*

Timothy Honablew
Carnegie Mellon University
Cornell University
Johns Hopkins University (Baltimore Scholar)
Massachusetts Institute of Technology
North Carolina A&T State University*
University of Maryland, College Park (Honors)
University of Maryland, Baltimore County (Meyerhoff Scholar)
Yale University

Michael Howarth
Georgetown University*
Temple University

Faith Hudnall
Chatham University
Morgan State University*
Towson University
Virginia State University

Rohan Kane
Northern Arizona University
University of Colorado, Boulder
University of Maryland, College Park (College Park Scholars)*
University of California, Santa Barbara
University of California, Santa Cruz

Ryan Lai
University of Maryland, Baltimore County
University of Maryland, College Park*

Cecilia Lavorgna
Drexel University
University of Colorado, Boulder
University of Maryland, Baltimore County
University of Maryland, College Park (Carillon Communities)*

Raquel Legaspi
Bucknell University
Johns Hopkins University (Baltimore Scholar)*
Lafayette College
Loyola University of Maryland
University of Maryland, Baltimore County
University of Maryland, College Park

Ruth Martin
Daemen College
DeSales University*
Gannon University
Johns Hopkins University (Baltimore Scholar)
Saint Francis University
University of Maryland, College Park (College Park Scholars)

Chenille McCullum
Frostburg State University
Morgan State University
Pennsylvania State University
University of Maryland, Baltimore County*
University of Delaware
University of Maryland, College Park
Villanova University

Daisha McIlwain
Hampton University
McDaniel College*
Mount St. Mary's University
North Carolina A&T State University
Temple University

Abby McKenna
University of Maryland, College Park (Honors) – Banneker Key Scholar*
University of North Carolina, Chapel Hill
University of Richmond
Tufts University
Washington University in St. Louis

Class of 2019: College Acceptances

Michelle Mokaya
Boston University
Johns Hopkins University*
University of Maryland (Honors) – Banneker Key Scholar
North Carolina A&T (Honors)
Northeastern University (Honors)
University of Pittsburgh

Adi Mwangi
MICA
Rochester Institute of Technology
Savannah College of Arts and Design
University of Maryland, Baltimore County*

Omobolade Odedoyin
Johns Hopkins University (Baltimore Scholar)*
New York University
Rutgers University (Honors)
University of Maryland, College Park (Honors)

Chiad Onyeje
Bucknell University
University of Maryland, Baltimore County (Meyerhoff Scholar) *
University of Maryland, College Park (CIVICUS)

Ifasoke Owens
Rensselaer Polytechnic Institute*
University of Maryland, Baltimore County (Honors)
University of Maryland, College Park

Christian Pearson
Elizabethtown College
Morgan State University
New York Institute of Technology
Stevenson University *
University of Delaware
University of Maryland, Baltimore County (Meyerhoff Scholar)
University of Maryland, College Park (FIRE)

Rachel Pontious
Princeton University
University of Maryland, College Park (Honors)
Northeastern University
University of Pittsburgh (Honors)
Yale University*

Nayely Rivera Lavaire
University of Pennsylvania (Quest Bridge Scholar)*

Hercules Rodesno-Hercules
Johns Hopkins University (Baltimore Scholar)
Princeton University
Rensselaer Polytechnic Institute
University of Maryland, College Park (Honors)
University of Southern California
University of Virginia
Yale University*

Taylor Young
Drexel University
Hampton University
Howard University
Johns Hopkins University (Baltimore Scholar)*
McDaniel College
University of New Haven
Temple University

Elizaveta Zheleznyakova
Princeton University*

Notable College Scholarships

2019 Johns Hopkins University Baltimore Scholars (Full Ride Scholarship): Omobolade Odedoyin, Taylor Young, Evains Francois, Henry Rodesno-Hercules, Brandon Dillow, Timothy Honablew, Tori Legaspi, Ruth Martin

Emory University Scholarship (Full Ride Scholarship) : Lily DeBell

Banneker Key Scholarship (Full Ride Scholarship): Nathaniel Alper, Evains Francois, Abigail McKenna, Michelle Mokaya

Northeastern University Honors Scholarship ($120,000): Nathaniel Alper

St. John's University - Presidential Scholarship ($164,000): Corbett Glaros

Temple University Presidential Scholarship ($131,904): Abigail McKenna

Hampton University Merit Scholarship ($120,000): Timothy Honablew

University of Pittsburgh University Scholarship (Full Ride Scholarship): Rachel Pontious

Bauer Scholars, Bucknell University: Tori Legaspi and Chiad Onyeje

North Carolina A&T Merit Scholarship (Full Ride Scholarship): Timothy Honablew

Questbridge Scholar (Full Ride Scholarship): Nayely Lavaire-Rivera

To date, the Class of 2019 has earned well over
$7,000,000 in scholarship money!

Research Awards and Honors

The Regeneron Science Talent Search

Michelle Mokaya was selected as a semi-finalist scholar in the 2019 Regeneron Science Talent Search (formally named Intel Science Talent Search). As one of the top 300 scholars in the 78th Regeneron Science Talent Search, Michelle received $2,000 to use toward STEM-related activities. Michelle's project, "Detection of *Schistosoma Mansoni* DNA from Filtered Urine Samples Using a Multiplex PCR," was completed her project at Johns Hopkins Bloomberg School of Public Health, in the Department of Molecular Microbiology and Immunology. Dr. Alan Scott mentored Michelle as she learned about parasitic DNA detection. Her project goal was to find a new diagnostic approach to detect the presence of *Schistosoma mansoni*. By using filtered urine samples, Michelle used polymerase chain reaction (PCR) and gel electrophoresis to establish a working multiplex protocol to amplify *S. mansoni* DNA.

The Baltimore Science Fair (BSF)

First place winner in Biological Sciences: **Lily DeBell** for her project "Exonuclease-dependent protospacer processing during CRISPR-Cas immunity"
Honorable Mention for Biological Science: **Abigail McKenna**

Special Awards by Independent Groups at BSF

United States Army Award of Merit for an Outstanding STEM Project: **Helen Schott, Fiona Zabel, Rachel Pontious**
United States Coast Guard: **Lily DeBell, Jarra Omar**
American Society for Quality: **Rachel Pontious**
National Institute on Drug Abuse (NIDA), The Diversity and Outreach Committee, 3rd Place Award (mentored): **Karen Griffin**
National Space Society: **Caleb Clark, Rohan Kane**
Chesapeake Water Environment Association (CWEA): **Rachel Pontious**
Society for Science and the Public: **Helen Schott**

Maryland Junior Science and Humanities Symposium 2019 (JSHS)

Oral Presentation Awards

3rd Place – **John Halpin** – John was awarded a $1,000 scholarship and trophy for his project "Disrupting the Fatty Acid Binding Protein 2 Gene in Zebrafish Using CRISPR-Cas9 and a Gene Breaking Transposon."

United States National Physics Olympiad

Timothy Honablew and **Colton Ross** participated in the F = ma contest. 4,277 students took the exam nationwide. Colton scored 2 points above national average.

Mathematics Achievements

Future Scholars Program

Colton Ross and **Fiona Zabel** have been accepted into the Future Scholars Program at the Johns Hopkins University Department of Mathematics. The Future Scholars Program is an opportunity for high school seniors to take college math classes for Johns Hopkins credit.

Elizabeth Zheleznyakova successfully completed math courses this year at Johns Hopkins University as Future Scholars.

University of Maryland College Park High School Mathematics Competition

Colton Ross is a school winner. His high score on Part I qualified him to participate in Part II of the competition.

American Mathematics Competition (AMC)

AMC 12 school winner: Adam Hofert, 11th grade

AMC 10 school winner: Logan Sampath, 9th grade
Ingenuity team included Colton Ross (11th grade), Juni Polanski (10th grade) and John Overton (9th Grade)

Maryland Math League

Best solvers: Colton Ross, Nicolas Del Pino, Kyla Zurlage, Juni Polanksi, Tate Bothner, Nicholas Pham

Average SAT Scores for the Class of 2019

Math—708, Reading and Writing—697, Math 1—660, Math 2—724, Chemistry—723, Physics—623, Biology—654

800 SAT and SAT 2 Scores

Nathaniel Alper: 800 Biology, 800 Math 2

Lily DeBell: 800 World History

Samuel Harkness: 800 Biology, 800 Math

Colton Ross: 800 Math 2, 800 Math

Elizaveta Zheleznyakova: 800 Biology, 800 Math

Ingenuity Award Descriptions

The Leadership Award is presented to the student in each grade level who has 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 Will Povell Lighthouse Award (formerly the Comradery Award) is presented to the student in each grade level who demonstrates amiability and a collaborative nature, as noted by their peers and teachers. This award has been renamed in memory of Will Povell (Class of 2016) a beloved and treasured member of our community. Will was a bright light to all who knew him, embodying kindness and a willingness to help others. He made those around him feel valued and supported; his light inspired, and continues to inspire, others to shine their own. Seniors who receive this award are also presented with a college scholarship.

The University of Maryland Baltimore County (UMBC) Scholastic Balance Award is presented to the student in each grade level who demonstrates dedication to their extracurricular activities (e.g. sports, jobs, clubs, etc.) and effectively balances their activities with their school work. Seniors who receive this award are also presented with a college scholarship.

The Loyola University Maryland Community Betterment Award is presented to the student in each grade level who demonstrates outstanding dedication to helping and giving back to their communities through hours of volunteering in school clubs or outside organizations. Seniors who receive this award are also presented with a college scholarship.

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

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

The 13th Annual Karol S. Costa Ingenuity Award is presented to the student in each grade level who demonstrates outstanding inventiveness, originality, and ingenuity in the classroom, as noted by their peers and teachers. The Board of Directors established this award in 2005 in grateful recognition of Ms. Costa's contribution as the Founding Director of the Ingenuity Project. Seniors who receive this award are also presented with a college scholarship.

The Dolores Costello Tenacity & Grit Award is being presented to the student in each grade level who, despite encountering challenges, has demonstrated the perseverance, effort, self-advocacy, resiliency and passion to achieve long-term academic and personal goals.

Ingenuity Award Descriptions

Seniors Only

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

The Harbor Designs and Manufacturing STEM Achievement Award is presented to the **senior** who has distinguished himself or herself through exceptional work in computer science, computer engineering, or data science in or out of class. Harbor Designs and Manufacturing is a Baltimore City leader in producing state of the art designs and prototypes to commercialize and manufacture ideas into products.

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

The Dolores Costello Tenacity & Grit Award is being presented to the student in each grade level who, despite encountering challenges, has demonstrated the perseverance, effort, self-advocacy, resiliency and passion to achieve long-term academic and personal goals.

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

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

Caverly, Keara | Cole, Chelsea | DeBell, Lily | Dillow, Brandon | Francois, Evains | Glaros, Corbett | Goldsmith, Lily

Griffin, Karen | Halpin, John | Harkness, Samuel | Henley, Camille | Holland, Ula | Honablew, Timothy | Howarth, Michael

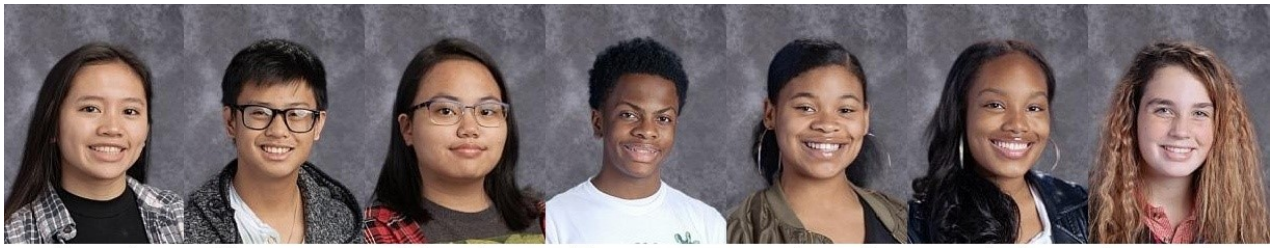
Hudnall, Faith | Kane, Rohan | Lai, Ryan | LaVorgna, Cecilia | Legaspi, Raquel | Martin, Ruth | McCullum, Chenille

McIlwain, Daisha | McKenna, Abigail | Mokaya, Michelle | Mwangi, Adi | Odedoyin, Omobolade | Onyeje, Chiad | Owens, Ifasoke

Pearson, Christian | Pontious, Rachel | Rivera Lavaire, Nayely | Rodesno-Hercules, Henry | Tsung, Wilfred | Weiss, Alyssa | Young, Taylor

Zheleznyakova, Elizaveta

Class of 2019

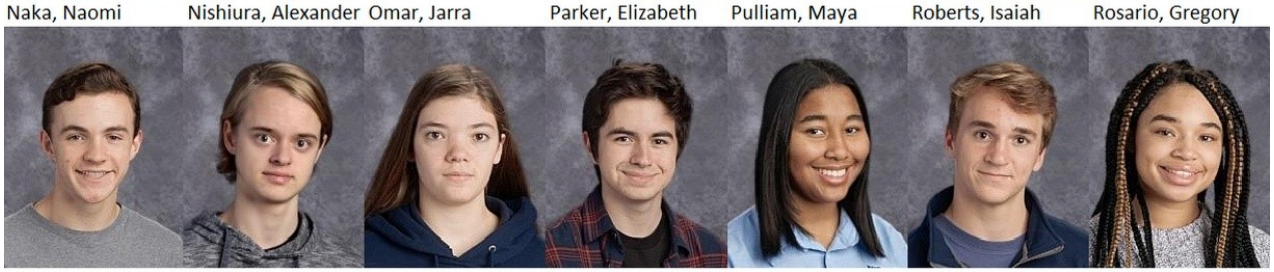


Amodia, Hazel | Arcillo, Matt | Badiola, Marie | Bolden, Cameron | Bossard, Hannah | Brown, Shania | Charney, Corinne

Clark, Caleb | Diouf, Mouhamed | Erdyanto, Stanley | Forbes, Gabrielle | Guchemand, Kamran | Halpin, Ella | Harris-Kupfer, Ari

Hernandez, Erick | Herrera, Miriam | Hofert, Adam | Hope, Peter | Le, Jacky | Lee, Noah | Marinelli, Katrina

Naka, Naomi | Nishiura, Alexander | Omar, Jarra | Parker, Elizabeth | Pulliam, Maya | Roberts, Isaiah | Rosario, Gregory



Ross, Colton | Sauchuck, Liam | Schott, Helen | Schutz, Alden | Smith, Mya | Stadelmaier, Ian | Stephen, Trinity

Texter, Emma | Thomas, Noel | Torbit, Donaysia | Watts, Tessai | Williams, Raekwon | Wingate, Ronald | Yoseph, Samantha

Zabel, Fiona

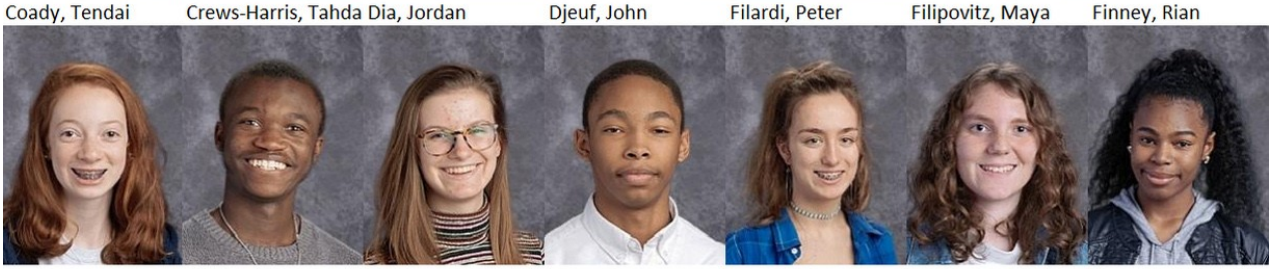
Class of 2020

Aladejebi, Michael | Alumbro, Julia | Amanze, Ihemriorochi | Anjorin, Obafemi | Barrera, Alejandro | Basoco, Ana | Beahn, Kaitlynn

Bhat, Shantika | Blankson, Jolynn | Borbash, Lucinda | Bothner, Tate | Brandon, Collin | Brody, Elias | Bushnell, Henry

Calderon, Lucas | Campbell, Riyan | Canick, Lucy | Celnik, Sabina | Chapman, Isaiah | Chen, Vina | Chng-Lim, Seth

Coady, Tendai | Crews-Harris, Tahda | Dia, Jordan | Djeuf, John | Filardi, Peter | Filipovitz, Maya | Finney, Rian



Fishkin, Stephanie | Hamilton Jr., Jerome | Hilger, Anna | Hill, Darius | Hull, Miranda | Jaffe, Madeline | Johnson, Akashia

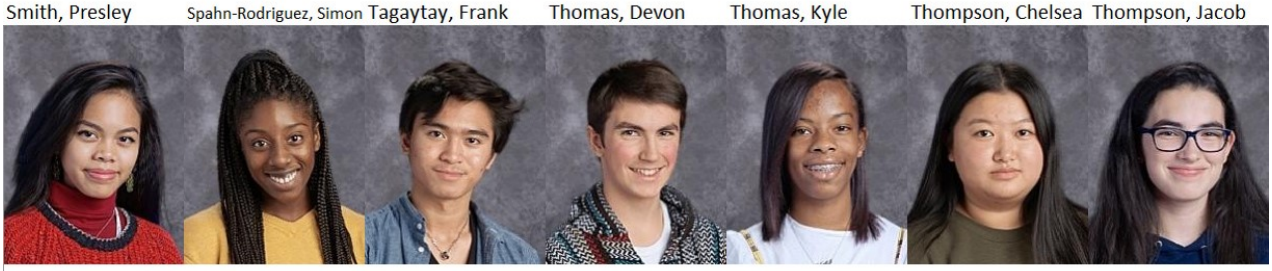
Johnson, Nolan | Kardas, William | Le, Nhan | Li, Sarah | Lyions, Wyatt | Malmin, Charlotte | Marchionni, Luce

McKenna, Kacey | Mokaddem, Aquib | Odeh, Patience | Paranilam, Jaela | Parmer, Eli | Petros, Mason | Pham, Nicholas

Pinkney, Jocelyn | Polansky, Juni | Restelli, Edward | Rhodes, Jayden | Richard, Isabelle | Sall, Boubacar | Samuel, Logan

Sanchez-Alvarez, Jorge | Schmitz, William | Schwartz, Tejal | Scott, Mariah | Selim, Sheikh | Simcox, Talya | Smith, Kristiana

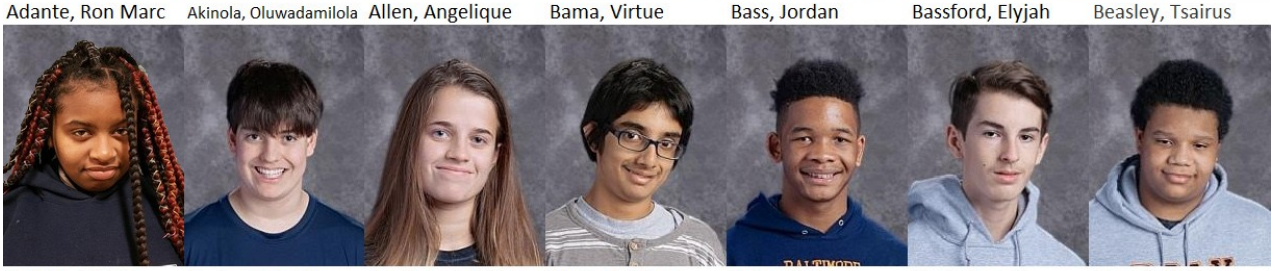
Smith, Presley | Spahn-Rodriguez, Simon | Tagaytay, Frank | Thomas, Devon | Thomas, Kyle | Thompson, Chelsea | Thompson, Jacob



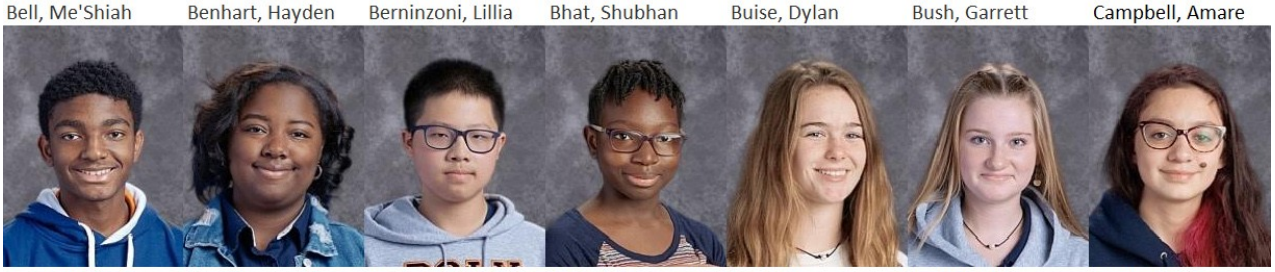
Torregoza, Agnes Al | Uma, Chielota | Villahermosa, Aaron | Weybright, Zachary | Wilder, Morgan | Zheng, Jennifer | Zurlage, Kyla

Class of 2021

Adante, Ron Marc | Akinola, Oluwadamilola | Allen, Angelique | Bama, Virtue | Bass, Jordan | Bassford, Elyjah | Beasley, Tsairus



Bell, Me'Shiah | Benhart, Hayden | Berninzoni, Lillia | Bhat, Shubhan | Buise, Dylan | Bush, Garrett | Campbell, Amare



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