THE 20TH ANNUAL

Ingenuity STEM Research Symposium

MAY 25, 2022

Baltimore Polytechnic Institute

Dear Guests,

Thank you for being a part of our Symposium Celebration. Symposium, an important hallmark of Poly Ingenuity's STEM education, gives students the opportunity to present the results of their original research. The Classes of 2022 and 2023 Ingenuity Research students worked hard to prepare for our first in-person Symposium in TWO YEARS! Students have shown tremendous resilience after a period of prolonged distance learning; tonight we get to show them how much support they have in the community.

Returning to in-person learning this year required rebuilding learning communities, restoring academic confidence, and innovating curricula to meet the needs of over 900 students in five Baltimore City Public Schools. Dedicated and skilled teachers are critical to meeting these objectives. Here are a few highlights of what they are accomplishing:

This year, Dr. Rosen, Ingenuity's Research Director, redesigned the 10th grade Research Curriculum, placing a new focus on our new Core Values for STEM leadership. Students now start by identifying a social problem and finding two STEM solutions that are or can be applied to the problem. **This shift has resulted in our largest-ever cohort of sophomores expressing high levels of interest in research!**

Our middle school teachers launched an ambitious multi-year goal to revise our math curriculum, beginning with Pre-Algebra this year. This has been a success with many learning opportunities, and they are planning for the next step - redesigning Ingenuity's Algebra curriculum and considering how we sustain models at all four middle schools to offer students the opportunity to take Geometry in 8th Grade.

Next year, we welcome our first cohort of entering 9th graders at Poly who participated in Ingenuity's newest middle school program at James McHenry. In the midst of a pandemic, the teachers and school leaders at James McHenry worked hard to establish the systems and traditions that make Ingenuity's middle school preparation a success.

This spring, we also celebrate the legacy of two gifted mathematicians who dedicated long careers to educating Ingenuity students. Please join me, and generations of alumni who were impacted by their teaching, in thanking them for their outstanding contributions.

Honoring Dr. Mikhail Goldenberg for 25 years teaching Ingenuity at Poly

Honoring Maya Spicinetskiy for 22 years teaching Ingenuity at Roland Park

Ingenuity students are the next diverse generation of STEM leaders. Their persistence, creativity, and leadership amaze us every day -- the knowledge and skills they develop now will help them solve the challenges of the future. Thank you for providing them with your wisdom, insight, and support. Together, we're shaping STEM's future.

Sincerely,

Lisette S. Morris
Executive Director

Developing Leaders Since 1883

Congratulations to the Ingenuity Poly class of 2022 for your research and discoveries!

Ad sponsored by Pat Tracy (Poly '72) & Robin Tracy (Western '73)

Honoring the teaching career of Dr. Mikhail Goldenberg for cultivating the mathematical minds of students for 25 years.

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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 nine years and has done an exceptional job in bringing great heart and vision to this already prestigious school.

The Ingenuity Project

A seven-year advanced STEM program providing curriculum, enrichment, and support to over 900 students in four middle schools and close to 20% of students enrolled at Baltimore Polytechnic Institute (Poly). In conjunction with fast-paced, content-rich mathematics and science classes taught by experienced teachers, research is emphasized through a multi-year, independent off-campus practicum guided by an Ingenuity research director in partnership with leading scientists and researchers.

Ingenuity Project Curriculum

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 also submit their research to regional science fairs, including the Junior Science and Humanities Symposium (JSHS) and Morgan State Science, Mathematics, and Engineering Fair.

The Innovation Practicum is a two-year sequential in-school and off-site research curriculum for 10th-11th grade Ingenuity students. Students work with mentors to create solutions to real challenges using Applied Mathematics, Computer Science, Machine Learning, Data Science, and/or Statistics and learn coding languages and/or statistical analysis programs.

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.

Ninth grade students begin their sequence with a year of Geometry: Proof and Problem Solving; tenth grade students complete a year of Algebra II and Elementary Functions, 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 such as Differential Equations and Linear Algebra. Some students have also qualified to take classes at Johns Hopkins University through the Future Scholars Program..

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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About the Keynote

Dr. Letitia Dzirasa, M.D.

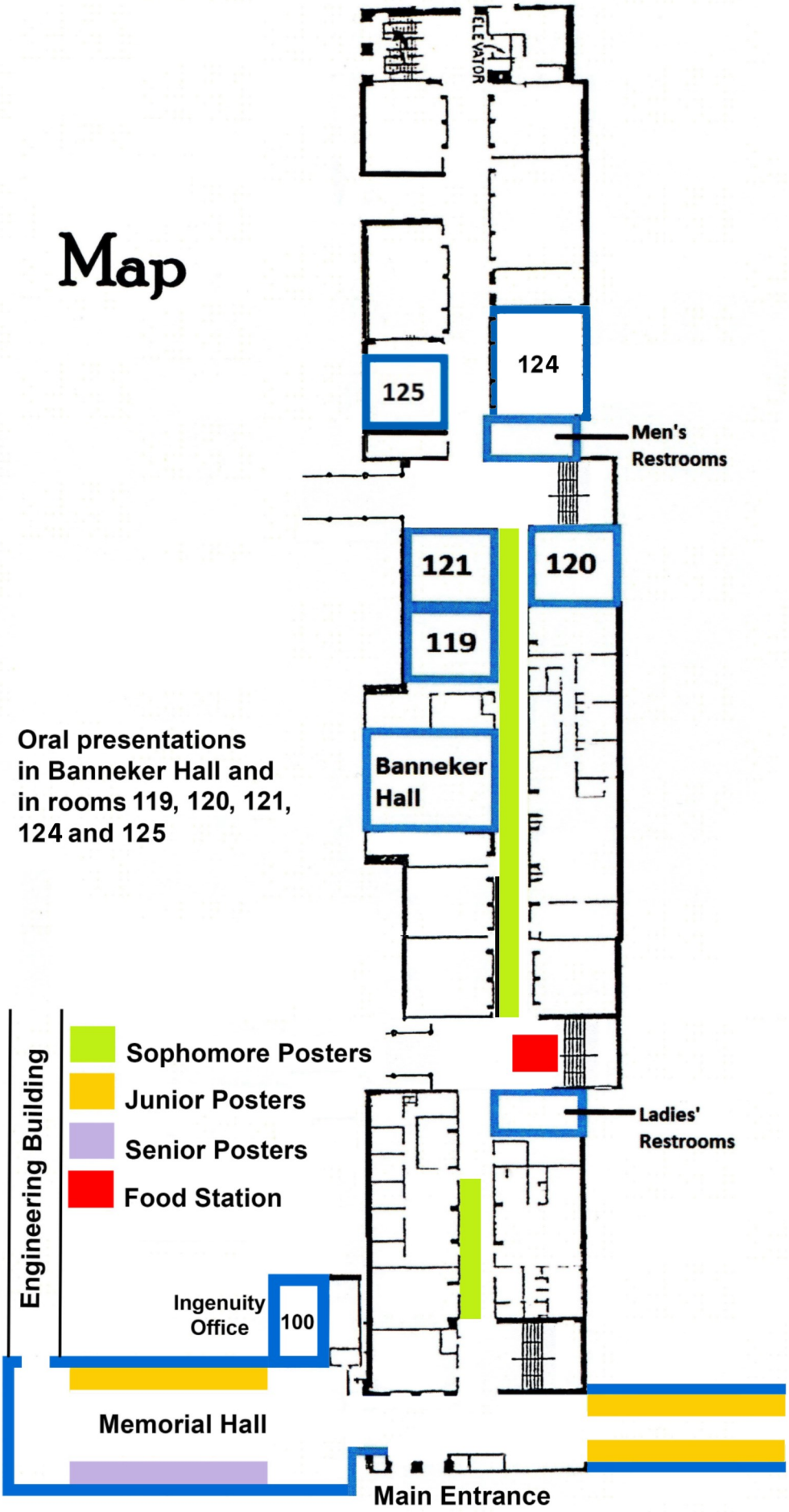
Johns Hopkins University
University of Maryland Baltimore County
Baltimore City Health Department
Commissioner of Health

Dr. Letitia Dzirasa joined the Baltimore City government as the Commissioner of Health in March 2019. Dr. Dzirasa, a Hopkins trained pediatrician, believes that equitable care is a basic right for all and will tirelessly advocate for programs that support the overall health and wellbeing of all Baltimore city residents. Dr. Dzirasa's special interests include obesity management and prevention, trauma informed care in children and adolescents, and expanded use of technology to improve health outcomes.

Prior to joining the Health Department, Dr. Dzirasa worked at Fearless Solutions (Fearless), a Baltimore based digital services firm that builds custom software solutions for local and federal government clients. In her role at Fearless as Health Innovation Officer, Dr. Dzirasa was responsible for managing the Healthcare Information Technology (HIT) portfolio for the company and provided clinical subject matter expertise to HIT projects. Dr. Dzirasa also has close clinical ties to the Baltimore community, having trained at the Johns Hopkins Hospital in pediatrics and having worked as medical director for school based health and quality at Baltimore Medical System from 2013-2016.

In addition to holding a B.S. from University of Maryland, Baltimore County in biological sciences, Dr. Dzirasa graduated from Meharry Medical College, Summa Cum Laude, in 2007. She lives in downtown Baltimore with her husband and son.

Map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6:55 - 7:50	Senior Presentations

PRESENTATIONS

6:55 - 7:10

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Room 119	Unexpected Events: Testing Current Capability of Autonomous Vehicles – ***Logan Sampath***
Room 120	The Acoustics of the Poly Auditorium – ***Elek Yuhas***
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Banneker Hall	Double Integral, Polar Coordinates, and Poisson Integral – ***Antonio Romerio & Josh Tagle***
Room 119	Developing Early Detection Methods for Ovarian Cancer – ***Zen Gordon***
Room 120	Spiral Ganglion Neuron Degeneration in SCD – ***Precious Conteh***
Room 121	PACMan Mitigating Bias in Proposal Reviews – ***Keith Ceruti***
Room 124	Examining a Fossil from the Ediacaran Period – ***Mia Schildbach***
Room 125	Fabrication of Circular Channels in Hydrogel to Model *in vivo Fluid Flow* – ***Jonah Schwartz***

7:35 - 7:50

Banneker Hall	Developing Early Detection Methods for Ovarian Cancer – ***Zen Gordon***
Room 119	Seafood Production and Trade in Micronutrient Deficient Countries – ***Ashantae Hayward***
Room 120	The Usage of Sumo Proteases (SENPS) as a Potential Cancer Biomarker – ***Nyla Powell***
Room 121	Premature Stop Codons in Extracellular Vesicle RNAs – ***Hayden Benhart***
Room 124	Using Machine Learning to Predict Ground Reaction Forces – ***Johns Hopkins***
Room 125	Solving First Order Homogeneous Differential Equations - ***Logan Sampath & Elek Yuhas***

Senior Research Abstracts

The seniors' presentations represent the culmination of their research efforts. Students completing Ingenuity Research Practicum 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 Morgan State University – Science-Mathematics-Engineering Fair.

Front Row (from left to right): Jala Wallace, Nyla Powell, Precious Conteh, Ashantae Hayward, Mia Schildbach

Second Row: Keith Ceruti, Zen Gordon, Logan Sampath, Meredith Nishiura, Jonah Schwartz

Third Row: Andrew Haye, Hayden Benhart, Johns Hopkins III, John (Elek) Yuhas

Senior Research Abstracts

Premature Stop Codons in Extracellular Vesicle RNAs
Hayden Benhart

Mentor: Dr. Sarven Sabunciyan
Department of Pediatrics, Johns Hopkins School of Medicine

Extracellular vesicles are small lipid bound particles that are secreted by cells to carry out various bodily functions. Since being discovered in the 1980's, our understanding of their specific functions has grown more in recent years (Harding et al., 2013). Major functions of extracellular vesicles are the transport of macromolecules, primarily nucleic acids, and proteins and use as disease biomarkers (Ramirez et al., 2017). Extracellular vesicles are also thought to help in the removal of misfolded proteins, although this requires future research to determine for sure (Deng et al., 2017). We are curious about other functions that may not have been fully explored and their potential impact on psychiatric disorders. We suspect that RNA containing premature stop codons is released by the cell to prevent the production of truncated proteins and this RNA is then removed by extracellular vesicles. Using RNA sequenced from extracellular vesicles and stored in Variant Call Format (VCF) files, we can look for premature stop codons in the extracellular vesicles. The direct goal of our project is to determine whether extracellular vesicles contain RNA that is different from their parent cells with our ultimate objective being to provide evidence to support the transport of RNA containing stop codons as a novel function of extracellular vesicles.

Mitigating Bias In Proposal Reviews through Machine Learning
Keith Ceruti II

Mentor: Dr. Louis Strolger
Space Science Telescope Institute

Allocating and distributing resources proves difficult, often lending to bias, whilst requiring months to plan and accomplish with marginal success. In context, astronomers from around the world require access to the unique capabilities of the Hubble Space Telescope (HST) and the James Webb Space Telescope (JWST). The Proposal Auto-Categorizer and Manager, also known as PACMan, is a tool being developed to help with time allocation for the Space Telescope Science Institute (STScI) in Baltimore MD. STScI's Time Allocation Committee (TAC) reviews thousands of scientific proposals received each year, making recommendations to assign time to hundreds for the telescopes. PACMan will assist the committee in mitigating expertise bias in reviewer assignments, leading to more efficient and reliable selections. Through a combination of a naive Bayesian classifier, vector cosine similarity, and other machine learning techniques, PACMan makes proposal-to-panelists assignments with relative accuracy. However PACMan still is in need of validation tests and metrics of its performance. Previous iterations used only abstracts to determine scores and categorizations. By analyzing the bodies of thousands of papers provided by the Semantic Scholar Open Research Campus (S2ORC), we can potentially find a way to better categorize the papers provided by the STSCI.

Senior Research Abstracts

Studying the Ediacaran Period through the examination of a fossil from the Deep Spring Formation of Nevada

Mia Schildbach

Mentor: Professor Emmy Smith
Supervisors: Graduate students Lucy Webb and Graduate Student
Department of Earth and Planetary Sciences, Johns Hopkins University

The Ediacaran Period (635-541 million years ago) preceded the Cambrian explosion, a diversification event where most modern animal phyla evolved. By studying terminal Ediacaran geology and fossils, scientists can better understand the causes of the Cambrian explosion and the conditions under which animals evolved and diversified. Ediacaran research is new and researchers are learning how organisms in the Ediacaran were more diverse and abundant than previously thought. The study's aim is to identify and describe Ediacaran fossils found within a rock sample from near the Ediacaran-Cambrian (E-C) boundary that are undocumented in the southwestern USA. These fossils were analyzed by conducting a literature review of globally described Ediacaran fossils and evaluating distinctive features of the fossils themselves. The fossils are generally 0.3-0.5 mm wide and range 5 mm to 25 mm long in length. The fossils do not contain transverse lineations and some of the fossils are branching. The preservation style of these fossils were analyzed through scanning electron microscopy with electron dispersive X-ray spectroscopy (SEM-EDS). While the fossils were originally hypothesized to have been preserved with pyrite, this hypothesis was rejected when SEM-EDS results suggested that the fossils were instead preserved with chlorite. Currently I believe that these fossils are examples of Vendotaenids based on their similar long and thin body type and the rare instances of branching in these fossils. Together, this research provides information about the diversity and preservation of organisms from the terminal Ediacaran and better characterizes organism turnover at the E-C boundary.

Soft Biomimetic Hydrogel Channels to Simulate *in vivo Blood Flow*

Jonah Schwartz

Mentor: Gayatri Pahapale
Supervisor: Dr. David Gracias
Department of Chemical and Molecular Bioengineering, Johns Hopkins University

All tissues in our body are interspersed with a vast network of microchannels that facilitate nutrient and oxygen distribution to cells and drains the waste out from the cell. To mimic this network of microchannels in a laboratory setting, researchers use microfluidic channels, which are essentially microchannels or ducts through the cells' environment. The most common technique used to fabricate the microfluidic devices is lithography, which yields channels with square and rectangular cross sections. However, channels in the body are circular, so that feature is very valuable. Although there are methods like micro-milling and 3D printing to create circular channels, these do not offer the flexibility of material, design, and scalability. Thus, it is still challenging to create channels that simulate the geometry of the in vivo channels and are also biocompatible. This project will discuss the fabrication of soft hydrogel based circular microfluidic 3 channels using molding. We have used different molding materials to generate soft hydrogel channels of various sizes and used gelatin, which is biocompatible and acts as an extracellular matrix that would simulate in vivo. We also demonstrate that efficient fluid flow can be achieved in these soft hydrogel channels and the flow pattern is similar to that observed in the rigid channels. Creating microchannels with circular cross-sections quickly and efficiently is essential for tissue engineering, and this study will offer a facile method for microfluidic fabrication.

Senior Research Abstracts

Spiral Ganglion Neuron Degeneration in Sickle Cell Disease
Precious Ekundayo Conteh

Mentor: Dr. Amanda Lauer
Supervisor: Dr. Nick Andresen
Center for Hearing and Balance at Johns Hopkins

Sickle cell disease (SCD) is an autosomal recessive disease that alters the structure and function of red blood cells, causing them to 'sickle' under low oxygen conditions. Symptoms of SCD include anemia, pain, frequent infections, and sensorineural hearing loss (SNHL). The cause of the hearing loss in SCD is unknown and studies have not been performed to analyze the cochleas of individuals with SCD. Spiral ganglion neurons (SGN) are an important component of the inner ear that translate the neural signals from the cochlea to the brain and SGN degeneration may be a cause of hearing loss in SCD. SGN counts were taken and compared between individuals with SCD and a control group using two-dimensional image analysis. The results were graphed and analyzed using the statistical software Prism. There was not a statistically significant difference between the experimental group and the control group. Results suggest that SGNs do not play a significant role in SCD-induced hearing loss, meaning that further studies of cochlear pathology in SCD should be performed in order to determine the etiology of SCD-induced hearing loss.

Developing Early Detection Methods for Ovarian Cancer
Zen Gordon

Mentor: Dr. Tonya Webb
Department of Microbiology and Immunology, University of Maryland School of Medicine

This research project is focused on developing a test to measure the ganglioside, GD3 for detecting ovarian cancer. Ovarian cancer is the most fatal gynecologic malignancy worldwide. This type of cancer is known to have mild symptoms, delaying diagnosis to later stages.where it is more aggressive and is harder to treat. Prior research has shown that ovarian cancers produce factors such as GD3 that can help tumors metastasize, as well as block anti-tumor immune responses. Given its small size, we hypothesized that GD3 can be used as a biomarker and that developing a test that can measure GD3 in the urine will help detect ovarian cancers, and potentially other cancers at an earlier stage. The goal of this project is to use classic diagnostic assays such as enzyme linked immunosorbent assay (ELISA), dot blots, and fluorescence microscopy to determine the level of sensitivity needed to measure GD3 in mouse ovarian cancer samples. All methods were able to detect GD3. However, ELISA was the most sensitive. In future experiments, we will focus on increasing the sensitivity of the assays.

Senior Research Abstracts

Cytoskeletal Influence in Signal Transduction
Andrew Haye

Mentor: Dr. Peter N. Devreotes
Department of Cell Biology, Johns Hopkins School of Medicine

Every year over 600,000 people die of cancer in the U.S. alone, with only limited therapies in sight. Metastatic cancers in particular exploit cell division and migration pathways to wreak havoc on healthy tissue. The complex mechanisms that control cell movement are currently being uncovered; to achieve cell movement, myosin motor proteins in coordination with actin filaments create protrusive and contractile events. Cytoskeletal proteins are organized by upstream Signal Transduction pathways. We want to uncover how these two networks, the Signal Transduction Excitable Network (STEN) and the Cytoskeletal Excitable Network (CEN), communicate with one another. Specifically, we set out to test the effects of myosin activity, considered to be part of CEN, on the upstream signaling pathways. By combining synthetic biology and fluorescent microscopy, we measured how rapid changes in myosin activity affected STEN molecules such as Ras. Our data reveal that lowering myosin activity leads to an upregulation in signal transduction activity. Currently, we are testing how cells with reduced myosin activity respond to chemical cues that guide cell migration. These findings will help us further understand how cell mechanics can influence signaling activity.

Seafood Production and Trade in Micronutrient Deficient Countries
Ashantae Hayward

Mentor: Dr. Phil McNab
Supervisor: Dr. Elizabeth Nussbaumer
Johns Hopkins Center for a Liveable Future (CLF)

Numerous countries globally are impacted by micronutrient deficiency crises. Earlier studies have established the nutritional benefits of seafood and its potential to alleviate micronutrient deficiencies. Some micronutrient deficient countries produce enough seafood to minimize their crisis, but they export too much of their catch. With the support of the Johns Hopkins Center for a Livable Future, this project allows us to study trade policies and other factors that might influence seafood exports in Nigeria, a micronutrient deficient country, to suggest potential interventions to allow greater volumes of micronutrient-rich seafood to stay in-country to support the health of their population. To do this I used R, a statistical software, to quantify and create graphics of seafood imports and exports in Nigeria. The data analysis showed that Nigeria imports a significant amount of seafood, even though they produce seafood themselves to sustain their population, but much of it is not accounted for because of illegal fishing. For the qualitative component, an analysis of trade policies in Nigeria and a literature review of programs and other policies was conducted. Through the policy analysis, it became apparent that Nigeria has strict laws surrounding foreign fishing in Nigerian waters, and the regulations associated with foreign fishing in Nigeria, but there are numerous exceptions to their laws and regulations.

Senior Research Abstracts

Using Machine Learning to Predict Ground Reaction Forces
Johns Hopkins

Mentor: Dr. Ryan Roemmich
Center for Movement Studies at the Kennedy Krieger Institute

Every year there are approximately almost 800,000 people who experience a stroke in the US alone, about 80 percent of whom lose some walking abilities and require physical therapy. It is important for therapists to be able to track a patient's recovery. A measurement that has been shown to correlate with the severity of a victim's loss in walking abilities, and could help track progress in physical therapy, is ground reaction forces (GRFs), the force you exert on the ground when you walk. Measuring GRFs requires expensive equipment, like force plates, and trained staff, making it hard to use in a clinical setting. This study explores the use of machine learning to predict GRFs from video, which could allow for GRF estimation with little to no equipment or training. Six different algorithms were trained with human gait data from the Center for Movement Studies at the Kennedy Krieger Institute, found using motion capture and force plates during treadmill walking. The most accurate of the algorithms was the random forest, with about 90% accuracy. This shows the viability of machine learning in predicting GRFs from human movement data, though more testing is needed to assess clinical efficacy.

Effects of an urban estuary on blue crabs and blue crab diet
Meredith Nishiura

Mentor: Dr. Eric Schott
Institute of Marine and Environmental Technology

Increasing development and urbanization greatly affects ecosystem dynamics in marine estuaries, yet these effects have gone underexplored. The blue crab Callinectes sapidus is a keystone species in the Chesapeake Bay, an estuary facing increased urbanization. Comparing data on blue crab diet to existing data on the prey community of the urbanized area can allow for a comprehensive picture of the interaction between blue crabs and the larger ecosystem. Data on the biodiversity of the Baltimore Inner Harbor were previously collected from biodisks, small disks placed in the harbor and allowed to accumulate a community of organisms. The resulting biomass represents the prey available to blue crabs, with barnacles, dark false mussels, oyster flatworms and clam worms composing the majority of biomass. DNA metabarcoding was used to compare these results to the stomach contents of blue crabs caught in the harbor, which resulted in an overamplification of blue crab DNA and underrepresentation of prey species, demonstrating the need for a blocking primer to suppress predator DNA. Future work will utilize a designed blocking primer to amplify prey species. The data may inform future research into the ecosystem dynamics of urban areas and provide insight into these marginal yet increasingly common communities.

Senior Research Abstracts

The Usage of SUMO Proteases (SENPS) as Potential Cancer Biomarker
Nyla L. Powell

Mentor: Dr. Michael J. Matunis
Department of Biochemistry and Microbiology, Johns Hopkins University

The small ubiquitin-related modifier, SUMO, is a protein that is conjugated to other proteins through an enzymatic cascade of E1, E2, and E3 enzymes. SUMO can also be removed from proteins through the activity of SUMO proteases, called SENPs. Many cellular processes regulated by SUMOylation are essential for human cancers. Therefore, inhibitors of SUMOylation are being developed by drug companies to treat cancer. TAK-981 is one such drug currently in human clinical trials and inhibits the SUMO E1 enzyme. Interestingly, SENPs are often misregulated in human cancers. Therefore, we aim to test the hypothesis that cancer cells with higher levels of SENPs are more sensitive to TAK-981 compared to normal cells with lower levels of SENPs, and thus establish SENP expression as a biomarker for TAK-981 therapy. As a step towards testing our hypothesis, we conducted a bioinformatics analysis of cancer cell line mRNA expression data and identified naturally existing cancer cells with varying SENP expression levels. In future experiments, we will use these identified cancer cell lines to test our hypothesis that cells with higher levels of SENP expression will be more sensitive to TAK-981.

Unexpected Events: Testing Current Capability of Autonomous Vehicles
Logan Sampath

Mentor: Carolina Pacheco Oñate
Mathematical Institute for Data Science, Johns Hopkins University

Self-driving vehicles use sensors and onboard computers to automate transportation. They have the capability to drastically reduce road accidents while also increasing vehicle efficiency. Most vehicle crashes are caused by human error; , and vehicles driven autonomously remove human error and can be shared more easily. However, autonomous vehicles cannot be allowed freely on the roads because they are not sufficiently accurate. The main challenge for self-driving cars is to adapt to novel situations. Many situations can be captured by data used to train systems, but at some point, the vehicle must adapt to a new, rare situation. A "heavy tail distribution" can represent this issue, where there is a long list of possible events, each with a low probability, creating a long "tail" in a probability distribution graph. To quantify the extent of this issue, we will characterize the capability of current systems to generalize to novel situations. To test the ability of state-of-the-art detection systems for vehicles, we will use a Python-based Mask R-CNN pretrained on COCO, and the NuImages dataset. The NuImages dataset has detailed annotations of specific objects, important for testing unexpected events. We compare the annotated and predicted bounding boxes and object categories. When testing the Mask R-CNN on the NuImages dataset, we can study the accuracy of the system and single out certain errors for further study. By observing the situations where mistakes are made, we gain a greater understanding of what specifically needs to be improved in the field of autonomous vehicles.

Senior Research Abstracts

Investigating Remdesivir PEP Activity against Measles Virus in a Rhesus Macaque Model
Jala Wallace

Mentor: Lisa Pieterse
Department of Molecular Microbiology and Immunology, Johns Hopkins University Bloomberg School of Public Health

Measles is a highly infectious virus associated with severe disease particularly in children. Following exposure, host antibody production against the measles virus can be detected within a few days of infection; such humoral immunity is expected to be sustained for the lifetime of the given host. Within the past two decades, measles virus cases in unvaccinated children have skyrocketed due to multifaceted social factors. Treatment of such patients exposed or infected with measles virus is limited to mitigating symptom presentation, as no specific antiviral treatments are available for measles virus infections. Remdesivir is an experimental antiviral medication shown to be effective in reducing measles viral loads in both *in vitro* and *in vivo* models by inhibiting viral replication via interference with RNA-dependent RNA polymerase function. In our study, we examined measles virus H and N protein-specific IgG antibody titers in sera collected from Rhesus macaque monkeys exposed to measles virus and treated them with or without remdesivir three or eleven days later. We then compared IgG antibody titers against specific measles proteins in the three days post-exposure prophylactic group (PEP) to titers within the eleven-day post-exposure treatment group and found that antibody titers were much lower in the PEP group relative to the treatment group, suggestive of successful early inhibition of measles virus infection in those monkeys treated early with remdesivir. Our study illustrates that remdesivir may be an effective post-exposure prophylactic agent in patients recently exposed to measles virus.

Senior Math Projects

Double Integral, Polar Coordinates, and Poisson Integral
Antonio Romerio and Josh Tagle

The goal of this project is to prove the famous formula $\int_0^\infty e^{-x^2}\,dx = \frac{\sqrt{\pi}}{2}$. First, we introduce the concept of the double integral. Second, we discuss polar coordinates and their applications. Finally, we show that evaluation of Poisson integral is equivalent to evaluating a relatively simple double integral in polar coordinates.

It is known that the function e^{-x^2} does not have an elementary antiderivative, so it is impossible to evaluate Poisson integral using Newton-Leibnitz formula. That means one needs to look for a special method to solve that problem. One of such methods is presented in this project.

Solving a Problem from a College Mathematical Journal, Three Different Ways
Aram Zaprosyan, Johns Hopkins, and Walker Johnson

Consider the segment of a tangent line to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ included between coordinate axes. What is the minimum length of this segment?
This problem appeared in the *Mathematics Magazine,* a journal which offers advanced college level problems to the people around the world. The "nice" answer to this problem is a + b, the sum of the semi-axes. The goal of this project is to show how to get to this answer in three different ways: using standard calculus in one variable, using calculus in two variables, in particular a method of Lagrange's multipliers, and applying AM-GM (arithmetic mean – geometric mean) inequality.

Solving First Order Homogeneous Differential Equation
Logan Sampath and Elek Yuhas

Consider the first order differential equation $\frac{dy}{dx} = f(x,y)$. When the function *f(x,y)* is "relatively simple," the differential equation can be converted to a more simple form which requires only integration. For example, if $f(x,y) = g(x) \cdot h(y)$, we can separate variables and integrate to obtain a general solution. We consider the case when *f(x,y)* is a homogenous function of degree 0. Such a function is a function of one variable *y/x*, and using the substitution $y/x = u$ we can reduce the equation to a separable one. We are discussing how an on equation of the form $\frac{dy}{dx} = \frac{a_1x+b_1y+c_1}{a_2x+b_2y+c_2}$ can be reduced to a homogenous equation. At the end, we give examples of solving equations which are mentioned above.

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 Morgan State University – Science-Mathematics-Engineering Fair and Maryland Junior Science and Humanities Symposium. The juniors, together with seniors, are also responsible for organizing the Symposium event.

Front Row (from left to right): Anna Rousos, Mara Coughlin, Sarah Patterson, Edith (Ouisie) Engelke, Mia Urban, Holland Low

Second Row: Kaif Rehman, Julio (Gabe) Alumbro, R'Reeyah Mabry-Francis, Iris Zheng, Yuki Lin, Malcolm Connor, William Grant

Third Row: John Angelloz-Dugan, Nicholas Santiago, Harrison Yezzi, Odin Adams

Junior Research Abstracts

Precipitations correlation with West Nile virus cases in California
Odin Adams

Mentor: Meghan Davis
Johns Hopkins Center for a Livable Future, Department of Environmental Health and Engineering

Since 1999, West Nile virus (WNv) has been a part of America's history, with 1% of cases developing neuroinvasive disease and a 9% mortality rate in neuroinvasive cases (it is estimated 70-80% of cases are asymptomatic). While temperature has been linked to WNv outbreaks, precipitation has been harder to link with WNv, despite its role in mosquito reproduction. Therefore, the goal of this research is to explore the impacts of precipitation on WNv cases in humans between the years of 2009 to 2014. In order to do this, data on monthly precipitation by county in California from the National Oceanic and Atmospheric Administration (NOAA) were linked to monthly human WNv cases by county from the California Department of Public Health. Associations between precipitation data and case counts are being explored with correlation tests in R. An analysis of these data might lead to a better understanding of how precipitation affects human WNv cases, which would help researchers better predict the occurrence of outbreaks. Better predictions of outbreaks could allow for disease prevention strategies to be put in place to mitigate WNv cases in humans.

Comparison of Composition Studies of Exoplanets
Julio Gabriel (Gabe) Alumbro

Mentor: June Wicks
Supervisor: Junellie González Quiles
Department of Earth and Planetary Sciences, Johns Hopkins University

The field of planetary science studies planets and stars to gain a better understanding of our universe's origin as well as learn more about the formation of planets. Exoplanets, planets outside our solar system, are an important aspect of this field as collecting data regarding these unknown planets can provide us useful insight on our own planet. Over time researchers have discovered more exoplanets and have created models for specific planets with intentions to learn more about planetary interiors. This meta analysis study aims to collect graphs, charts, and diagrams from previous studies and compare them with one another, finding key differences and the origin behind them. Mass x Radius graphs with 100% Fe will be compared with one another and 100% $MgSiO_3$ as well. Graphs are created through the pandas package in Python and graphs are created using polynomial and/or exponential equations coming from previous studies. After gaining sufficient data, the ultimate goal of this study is to create a database which stores the comparison of various graphs along with differences between these diagrams I believe is necessary to know, which is open to any researcher and scientist in hopes to aid them with any of their research in the future.

Junior Research Abstracts

Phenolic Content Relation to Harmful Algal Blooms
Mara Coughlin

Mentor: Taylor Armstrong and Dr. Allen Place
Institute of Marine and Environmental Technology

Harmful Algal Blooms are made of microscopic algae that release toxins into the environment. These blooms come into existence from the pollutants that humans put into water. The toxins released from these blooms have adverse effects on organisms in an affected area and cause damage not only to the ecosystem but also tourism industries and marine food sourcing. Phenolic content is chemical compounds found in organic matter; when found in water this would be due to the decomposition of plants and animals, or a result of runoff from a nearby source. Through this project I hope to find the correlation between Harmful Algal Bloom toxins and phenolic content. Samples for the project were collected from solid phase adsorption toxin tracking (SPATT) bags placed throughout New Jersey in different bodies of water. Spectrometry was used to find phenolic concentrations in said samples. Algal toxins from the SPATT bag samples were determined through liquid chromatography with tandem mass spectrometry. Toxins found include domoic acid, dinophysis toxins: okadaic acid, dinophysin-1, and pectenotoxin-2, esterified dinophysis toxins, goniodomin A, azaspiracid 1&2, and brevetoxin. The correlation between phenolic content and algal toxins could help determine the extent of which phenolic content inhibits toxic algae. The implications of this will lead to a better understanding of Harmful Algal Blooms and their behavior.

The Effect of Light and Heat Stress on the Photosynthesis of Cnidarians
Ouisie Engelke

Mentor: Dr. Phillip Cleves
Supervisor: Natalie Swinhoe

When the temperature of sea water rises,due to ongoing climate change, corals and other symbiotic cnidarians release their algae partners in a stress response known as ‘coral bleaching’. Coral animals form reefs, which are approximately one fourth of all marine species. The importance of saving these animals goes beyond the preservation of their species, but also the preservation of all organisms that depend upon them. The difficulty in coral research is their inability to be studied effectively in a controlled lab environment. Despite this, previous researchers have figured out that sea anemones are a good substitute to coral in experiments as they come from the same animal family of cnidarians, form the same algal symbiosis, and can be reared quickly. The sea anemone, Aiptasia, was used in this experiment. Although there are many studies regarding the specific heat temperatures at which corals bleach, the addition of light as a factor is unknown. To further the knowledge of light stress in addition to heat stress on Aiptasia, groups of anemone were exposed to different heat and light levels. Over the course of seven days, the number of algae cells remaining in the anemones was recorded and compared between heat and light treatments. Data collection for this experiment is ongoing, but it is anticipated that the highest light level will speed up the bleaching process. The data from this experiment will be exceedingly useful in determining why some corals bleach faster than others which will be helpful for future studies on bleaching.

Junior Research Abstracts

Investigating Relationships Between AGN Output and the ISM
William Grant

Mentor: Dr. Andreea Petric
Johns Hopkins University, Space Telescope Science Institute

Active Galactic Nuclei (AGN), highly energetic x-ray and infrared sources, have been a point of interest to researchers in recent years due to a greater abundance of information and data. Particularly, relationships between AGN and their hosts are being explored due to the possible implications of a link between them. The growing supermassive black holes that power AGN are also of interest, since the reasons behind their presence in some galaxies and not in others is not fully understood. Many theories have been proposed to explain these relationships, the most common being that they evolved together. To address these questions, my research will focus on the energy output of the central AGN and the surrounding ISM (interstellar medium), which fuels both star formation and the black hole, and possible correlation between them. Data were sampled from both the Chandra and NUSTAR telescopes, including a crossmatch with previous papers; the data is composed of x-rays because the shorter wavelength and higher energy of them allows them to pierce through the ISM recording more accurate data. This is especially true of the NUSTAR telescope which can operate at higher energies compared to previous telescopes (like Chandra). In particular, there will be a focus on correlating star formation rate with AGN activity. Hopefully, my research will establish a correlation between that energy output and the ISM; because the ISM is an important part of its galaxy, if a connection between AGN output on the ISM could be established, this would provide more evidence of how AGN, particularly their supermassive black holes, affect their hosts as a whole.

The Effect of Trichostatin A on Acetylation of Rel-A on the NF-κB Dimer
Sai Gayathri Kurup

Mentor: Dr. Laura Ensign
Supervisor: Marina Better
Department of Ophthalmology, Johns Hopkins School of Medicine

Preterm birth (PTB) is the leading cause of infant mortality worldwide and can cause life-threatening complications for both the parent and child. More than a quarter of all PTBs are attributed to inflammatory response signaling, typically due to infection. NF-κB, a protein that induces inflammation by producing cytokines, has been previously identified as a potential drug target for Trichostatin A (TSA), a histone deacetylase inhibitor (HDACi) that prevents the removal of acetyl groups on histones and other proteins. TSA has been shown to prevent PTB in murine models. However, the mechanisms behind how this HDACi downregulates inflammatory proteins through interference with NF-κB signaling remains largely unknown. NF-κB consists of two subunits, one being RelA, where a lysine acetylation site and potential HDACi target is located. To elucidate the interaction between TSA and NF-κB, I will use PHM1-41 human myometrial cells in a treatment with TSA. Following this, the cells will be harvested and an immunoprecipitation experiment to pull down the acetylated lysine sites on RelA will be conducted. I will then probe the pulldown sample for RelA via western blot analysis. I hypothesize that due to the properties of the HDACi, the RelA acetylation site will remain acetylated in the TSA treated cells. Through showing that TSA helps to maintain the acetylation site on RelA, we can begin to understand the mechanism of inflammation reduction for the goal of using HDACi as a therapeutic for PTB.

Junior Research Abstracts

Determining whether enoxolone inhibits HNF4a
Yuki Lin

Mentor: Dr. Steve Farber
Supervisor: Dr. Daniel Kelpsch
Carnegie Institute for Science, Department of Embryology, Johns Hopkins University

Lipoproteins are the body's way to transport fat, lipids and cholesterol to different parts of the body, but too many lead to blood clots and heart disease, causing 1 in 4 deaths in the U.S. However, too few lipoproteins can lead to death as the body's necessary proteins are not being produced and transported. Current drugs turn off the lipoprotein pathway completely which makes the body unable to function properly therefore new drugs are needed. The Kelpsch drug screen tested 3000 drug compounds and found 48 hits. One of the hits, enoxolone, a compound from licorice has been validated to dose dependently reduce luminescence and determined not to be a NanoLuciferase inhibitor. HNF4a is a protein that regulates gene expressions such as ApoB. BIM5078 and BI-6015 are known HNF4a inhibitor drugs and from preliminary data, they have shown that they can reduce luminescence, but more replicates are needed to confirm this. If enoxolone is found to be an HNF4a inhibitor in zebrafish then we will continue with a pharmacogenetics approach in which we will cross homozygous HNF4a to homozygous ApoB zebrafish to get heterozygous fish with our alleles of interest. If enoxolone is found to reduce lipoproteins without HNF4a then it might be a possible drug able to reduce lipoproteins. With new drugs the risk of people getting heart disease will be lower and lead to less people dying each year due to heart disease.

The Role of Reaction Time in Weakly Electric Fish During Active Sensing
Holland Low

Mentor: Dr. Noah Cowan
Supervisor: Yu Yang
Department of Mechanical Engineering , Johns Hopkins University

Active sensing is the use of energy in exchange for the acquisition of information regarding one's surroundings. An example of active sensing would be searching for something in the dark with your hands. Active sensing allows humans to understand and adjust to potential obstacles through the use of senses; the use of senses allows humans to make decisions based on what information they have gathered from them. Because both humans and electric fish have multisensory systems, they share similarities in active sensing behaviors. Scientists have studied how the electric knifefish adapt to experimental stimuli through active sensing in similar approaches as humans. However, few studies have focused on how reaction time influences active sensing in animals and/or humans. Reaction time can be thought of as the delay at which one physically responds to an event that sparks a response— such as the amount of time a sprinter needs to begin running after hearing a gunshot. The goal of my research is to determine the relationship between active sensing and reaction time by using the glass knifefish. My hypothesis is that active sensing performances of these fish will prove to be more efficient as their reaction-time decreases. In this experiment, the glass knifefish will be using active sensing to track a moving tube. I will be using the concept of feedback control loops and MATLAB to design a filter that will adjust the reaction time of the fish, and program the tube that will serve as a refuge for the knifefish species in this experiment. The planned procedure to experimentally manipulate reaction time and test its effect on active sensing is still in development, so the results are yet to be determined. However, I anticipate that the modified reaction times of the fish will call for more movement during active sensing procedures to account for the delay. in the improvement of tracking the refuge. Through the study of its relation to active sensing, we can continue to model robots and make comparisons among humans and other animals. These robots can be used in future experiments or jobs; furthermore, designs may be crafted and tested for the purpose of human benefit in the future.

Junior Research Abstracts

Exploring Adverse Childhood Experiences Among Men Who Have Sex with Men
Sarah Patterson

Mentor: Dr. Jacky Jennings
Supervisor: Alexandra Mueller
Department of Pediatrics, Johns Hopkins School of Medicine

Adverse Childhood Experiences (ACEs) are traumatic events that can occur from birth to adolescence which can lead to increased risk behaviors, such as substance use. This problem is more prevalent among urban men who have sex with men (MSM) due to the fact that they are more susceptible to certain health conditions. However, the association between substance use and ACEs is understudied among MSM. The objectives of this study were to determine the prevalence of ACEs among urban MSM, and to determine the association between factors including substance use and ACEs among urban MSM. MSM were sampled from sexual health clinics in Baltimore between 2018-2020 and were asked to complete an audio computer-assisted self-interviewing (ACASI) survey at baseline visit. An exploratory analysis and a bivariate analysis were performed to compare the frequency of substance use among those who experienced ACEs and those who did not. The impact of these results would help prevent the formation of negative coping mechanisms in adulthood due to the trauma experienced in childhood. In addition, it could aid in the intervention of adults abusing substances, granting an understanding as to why they have resorted to these coping mechanisms.

Analysis of Carbon Isotopic Values and Small Shelly Fossils of the Poleta Formation in the Lower Cambrian
Kaif Rehman

Mentor: Dr.Emmy Smith
Supervisor: Val Aguilar
Department of Earth and Planetary Sciences, Johns Hopkins University

Ancient reefs from the lower Cambrian period (~540-520 million years ago) provide unique insight into the environment of the time, as well as the creatures that inhabited it. Our goal is to observe fossil evidence, as well as to conduct an in-depth analysis of carbon isotopes, in order to better understand the complexities of the time. Carbonate rock samples were collected from the Poleta Formation in Esmeralda County, Nevada, a supposed Cambrian assemblage. We ran these samples through a mass spectrometer in order to measure heavy carbon isotope values (δ13C). We also used an acetic acid solution to dissolve some of the rocks and collect phosphatized fossils for study under a microscope. The δ13C of the Formation ended up being very similar to those of other Cambrian reefs, and the fossils represent small shelled organisms expected from the time period. Understanding the relationships between different formations from the lower Cambrian is vital in painting a clearer picture of the time, as no one site can give us the full story. This shows us that the Poleta Formation is from the Lower Cambrian. Our biostratigraphic and chemostratigraphic (fossil specimen and δ13C data, respectively) will be available for future paleontologists to use and analyze for comparison against other deposits.

Junior Research Abstracts

Effects of Gene Knockout on Microglia within Alzheimer's Disease
Nicholas Santiago

Mentor: Dr. Tong
Department of Neuropathology, Johns Hopkins University

Alzheimer's Disease (AD) attacks the brain and constantly destroys neurons. This results in the deterioration of memory and cognitive function. Microglia are cells found in the brain and are responsible for keeping it clean of unwanted substances. But within AD, microglia falter and cannot clear out all the harmful proteins produced during AD. At this point, microglia spiral out of control and become very hurtful for the brain. Due to microglia injuring the brain, lots of research is focused on the impacts of different genes on functions of microglia. The goal of my research is to study the effects of knockout (deletion) of specific genes Apoe-4 and Trem2 on microglia during AD. To accomplish this, unique technology must be used to alter parts of the genome of mice. After mice mature, brain samples of various mice will be observed to understand the impacts the deleted genes have on microglia. I hypothesize the deletion of Apoe-4 and Trem2 will have positive effects on microglia, consisting of less pro-inflammatory microglia, an increased amount of healthy microglia, and less amyloid-beta (Aβ) plaques, as both genes increase the probability of AD. Along with Apoe-4 and Trem2, research may also be done on the effects of other genes in microglia. A more thorough understanding of what makes microglia harmful would progress the ability to treat microglia to slow AD.

Fish Locomotion on Land
Mia Urban

Mentor: Dr. Chen Li
Supervisor: Qiyuan Fu
Department of Mechanical Engineering, Johns Hopkins University

Animals have always been studied in order to inform robotics. Birds were studied in order to build airplanes and helicopters. Cockroaches and snakes have been studied in order to build search and rescue robots. In my research, I am studying how three types of fish, mudskippers, ropefish, and bichirs, move on mud. This research can be used in the future to build robots that can traverse muddy terrain. When studying the terrestrial locomotion of mudskippers, ropefish, and bichirs, much is already known about how these fish move on flat, solid ground, but not something more complex like mud. Mudskippers use a "crutching" movement with their pectoral fins, ropefish use lateral undulation, and bichirs sort of combine the two, using some lateral undulation and their pectoral fins. To study how these fish move on mud, I have 12 cameras oriented around a container of mud. The cameras will record different angles of how the fish move on the mud, and these videos will then be analyzed using DLTdv8 to find any patterns within the locomotion strategies used. While no experiments have begun yet, I expect to find some similarities and differences between the strategies used by the fish and I will be able to determine which fish has the most effective locomotion strategy. This research can be used to design the most effective robot that can traverse muddy, amphibious terrain.

Junior Research Abstracts

Variation in Cell Mechanics in Response to a Stretch Force
Harrison Yezzi

Mentor: Dr. Daniel Reich
Department of Physics and Astronomy, Johns Hopkins University

The development and function of an organism depend on its environment and response to physical influence. These responses occur throughout the organism, including at cellular levels. Cells respond to physical forces with biological responses through a process called mechanotransduction. The main part of a cell responsible for exerting and absorbing force is the cytoskeleton. A cytoskeleton's mechanics can be altered in a multitude of ways including disease, maturation and in response to strain. However, the impact of stain on the mechanics of individual cells remains mostly unclear. In order to understand how the mechanics of cells are altered in response to strain a cell placed on an active micropost array will be stretched, the traction forces of the cells will be measured before and after a long term linear stretch is applied to the cells. Using a PDMS stretching device, a cell cultured on the posts, will be stretched *for a certain amount of time*. *The force of the stretch will remain constant and linear.* These measurements will be quantified using Igor pro software. Results from the experiment will elucidate information regarding the behavior of the cytoskeleton in response to force. These results will aid in a variety of fields such as regenerative stem cell medicine and cell therapies.

Suspension Feeding Invertebrate Communities Growth, and Filtration Capacity Between Various Substrates in the Chesapeake Bay
John Angelloz-Dugan

Mentor: Dr. Eric Schott
Institute of Marine and Environmental Technology

The health of urban estuaries is highly important in modern society yet these waters continue to be damaged by urbanization and industrialization. Understanding the factors that influence an estuary's health, and finding ways to influence their health, is becoming increasingly important. In this study, I am looking at the efficacy of various substrates at maintaining suspension feeding invertebrate, fouling, communities with the intention of finding an affordable and effective way primarily to lower Chlorophyll-A levels and reduce turbidity. This was achieved through creating multiple racks each holding rods that were made of a substrate we intended to test, and suspending the racks in the water at three separate sites to measure the fouling community that developed. We are planning on testing both the mass of the fouling community developed and the filtration capacity of the community at one month intervals over six months total.

Junior Research Abstracts

Effects of Mental Framing on Subjective Valuation of Effort in Decision Making
Malcolm Connor

Mentor: Dr. Vikram Chib
Supervisor: Grace Steward
Kennedy Krieger Institute, Center for Movement Studies

Previous research has shown that mental framing, taking a unique perspective on a situation, has affected loss aversion in gambling scenarios involving monetary loss and gain. Such effects have yet to be shown in decision making involving other kinds of loss and gain. Many parallels between effort-based and monetary decisions have been drawn by other previous studies. This study seeks to deepen the connection between these two types of decision making by evaluating whether or not mental framing affects the aversion to effort expenditure in effort-based decision making. Participants were recruited over Amazon's mechanical turk service, and responded to batteries of decisions while evaluating these decisions using one of two strategies. These decisions involved options with varying levels of monetary reward and difficulties of the effortful tasks required to obtain the rewards. In keeping with previous studies involving mental effort, the N-back task was used as an effortful negative aspect to these choices. The results of this study would show whether or not the effects of mental framing extend to people's valuation of effort, drawing another connection between different kinds of losses and gains in decision making. Understanding the influence mental framing has on the perception of effort also has potential applications in strategies to combat conditions that have been shown to affect one's perception of effort.

Analyzing how prosthetic skin texture affects object surface discrimination
R'Reeyah Mabry-Francis

Mentor: Dr. Jeremy Brown
Supervisor: Neha Thomas
Haptics and Medical Robotics (HAMR) Lab, Johns Hopkins University

Upper-limb absence causes significant impediments in amputees' ability to execute everyday tasks. Even though prostheses can restore some lost functions, most do not provide touch feedback to the amputees. In order to return the sense of touch back to amputees, touch sensory feedback systems started to be applied to prosthetics. Able-bodied individuals are able to identify various textures and surfaces with touch, unlike amputees who have to rely on visual cues to determine the rough or smoothness of a surface. To allow amputees to be able to determine the surface texture through passive haptic feedback, a textured skin will be developed for the prosthesis fingers to enhance surface discrimination. Four prosthetic molds will be created with different exterior textures/patterns ranging from minimally rough to maximally rough. An accelerometer will be applied behind the skin to measure the vibrational profile of a given material (e.g.,water bottle, bubble mat, limestone, tree bark) as the manufactured skin is dragged across it. MATLAB will be used to analyze accelerometer readings and patterns generated by the textured skins across the various material surfaces to see if a particular skin can better differentiate various materials. Because rougher skin texture has a larger surface area, it is expected that rough skins will naturally be able to capture the important features of a given object surface. If a textured skin can passively amplify features in different types of materials, it offers a low-cost solution to allowing amputees to feel and do more.

Junior Research Abstracts

Interference Activity of E. Coli CRISPR-cas System on Insertion and Deletion Off-Target Sites
Iris Zheng

Mentor: Dr. Scott Bailey
Supervisor: Morgan Beckett
Department of Biochemistry and Molecular Biology, Johns Hopkins University Bloomberg School of Public Health

CRISPR-cas systems show great promise as gene-editing tools across a broad range of applications, most notably for the treatment of genetic diseases. CRISPR-cas systems are utilized by bacteria and archaea as adaptive immune systems. Immunological memory is developed by incorporating the genetic material of invading bacteriophages into the host genome as spacers. During the interference process, the CRISPR- cas complex targets and degrades foreign DNA identical to the spacer. However, infectious genetic elements evolve to evade the host cell's adaptive immune system by incorporating mutations into its sequence that can hamper interference activity and effectiveness. Previous work has examined the effect of target sequence point mutations on CRISPR-cas interference activity. However, it is unknown how insertion and deletion mutations at target sites can impact interference activity. My work aims to determine the interference activity of E. Coli CRISPR-cas systems in the presence of off-target sites with insertion and deletion mutations. To answer this question, interference assays were performed on DNA targets (spacer: sp7x7), in Escherichia coli cells, with one insertion or deletion introduced at different locations. Interference activity was verified using gel electrophoresis. Implications of this work may tell us how the position of insertion and deletion mutation on target sites can influence interference activity. This would allow researchers to design optimal CRISPR-cas systems that reduce off-target effects and increase its specificity and effectiveness as a genome editing tool.

Exploring factors that contribute to irregularities in manufactured antibodies
Anna Rousos

Mentor: Dr. Jeffrey Gray
Co-mentor: Ranjani Ramasubramanian
Department of Chemical and Biomolecular Engineering, Johns Hopkins University

Antibodies are key in fighting off infections in the human body. They bind to the intruder to neutralize it, which prevents it from causing further infection; however, sometimes our bodies do not produce enough antibodies or the infection is just too strong for our antibodies to fight off on their own. Manufactured antibodies attempt to solve this issue, as they are lab-created antibodies that mimic natural antibodies. However, lab-engineered antibodies when used as a treatment are not always consistent in how they act when intravenously injected into the patient. The goal of my research is to figure out what factors contribute to these differences. I will be using PyRosetta, Rosetta, Python, and a variety of subsets within machine learning to this end. I am currently learning PyRosetta and about different types of machine learning methods used for antibody research, so the results are to be determined. However, I anticipate that modifying certain parts of the antibody could result in poor stability in the antibody's variable region, which would result in inconsistent effectiveness in the antibody's ability to target antigens. Through this study, we can gain a better understanding of what may be causing manufactured antibodies to be inconsistently effective. Figuring out what is causing these differences can allow the technology to be used for a wider variety of infections. The results would also improve our understanding of manufactured antibodies and give researchers an understanding of what to watch out for when creating antibody models in the future.

Junior Innovation Abstracts

The Innovation Practicum is a two-year sequential in-school and off-site research curriculum for 11th grade Ingenuity students. Students gain hands-on experience in Applied Mathematics, Computer Science, Machine Learning, Data Science, and/or Statistics and learn coding languages and/or statistical analysis programs. The primary goal is for student investigators to plan and implement their own scientific research project. The program is open to any Ingenuity student in good academic standing who wishes to apply, as the curriculum is designed to meet students' individual needs and ability levels.

Front Row (from left to right): Hero Williams, Samuel Rufus Doroja, Eden Rhodes, Chloe Harrison

Second Row: Skylar Strickler, Murad Habtu, Jordany Roman Gonzalez, Frebruk Mikre, Jalen Hensen

Junior Innovation Abstracts

Auditory Detection of Respiratory Illness
Jalen Henson

Mentor: Drew Grant
Supervisor: Dr. James E. West
Department of Electrical and Computer Engineering, Johns Hopkins Whiting School of Engineering

Scientists have stepped up to the challenge and considered how audio recordings of speech/breathing sounds could be used as a quick, effective, and non-invasive diagnostic tool. By using said diagnostic tool, we will be able to successfully diagnose a patient with COVID-19 or Asthma. By using machine learning, Python code, and audio files of ill patients, mainly collected and uploaded online by other researchers, we are able to quickly identify patients COVID status with a proficiency rate of 80%. While graphing an audio file using Python is visually appealing, looking solely at the visual of the audio sample won't be of any use. Instead, identifying similar features of sick and healthy patients is essential in this process. After correctly identifying features, we must constantly feed our database with examples of these results so that when the time comes, it'll be able to identify differences between sick and healthy patients. In the near future, I plan to use this knowledge of auditory detection to further my research on Asthma patients.

Training Set Data Generation For Rational Materials Design
Hero Williams

Mentor: Dr. Paulette Clancy
Supervisors: Connor Ganley and Maitreyee Sharma Priyadashini
Johns Hopkins University, Computational Materials Lab

Thermoelectric materials are a source of renewable energy which convert a temperature gradient into electrical energy. However, they are not very efficient at energy conversion and they are expensive to manufacture. To address this issue, this work focuses on optimizing the material discovery process, which is normally a time-consuming and expensive process when done in a physical lab, by utilizing computational tools. A promising design for a thermoelectric material includes a polymer backbone doped with another polymer to make it more electrically conductive. This complex is then bathed in solvent molecules to process it. Since there are multiple choices for each of the components, the combinatorial space for possible configurations is large, which makes exploration by experimentation difficult. As such, an efficient approach to find the optimal polymer-dopant-solvent system is to use machine learning; specifically, an algorithm called Bayesian optimization. The goal in this project has been the generation of the data set necessary to run this algorithm, which consists of digital representations of the selected systems, compiled with molecular dynamics simulations using a program called LAMMPS and optimized with the OPLS force field. In the future, the generated training data set will then be input into the BayesOpt algorithm to find promising candidates, according to efficiency or solubility. The best candidates can be sent along to a physical lab for more testing and further development with the end goal of an improved design for thermoelectric materials. Using rational methods, such as the one proposed in this work, will greatly reduce the cost and time required for material discovery, supporting the effort to move towards green energy.

Junior Innovation Abstracts

Compressor Maps and Engine Determining Lift Values
Samuel Rufus Doroja

Mentor: Dr. Joseph Katz
Supervisor: Ayush Saraswat, Subhra Koley
Department of Mechanical Engineering, Johns Hopkins University

Propulsion systems in aircraft are very important, in conjunction with the wings, they determine how they fly. Several experiments plotted on a compressor map – a chart showing the performance of a compressor through the relationship between pressure rise and mass flow rate – have shown that a set decrease of flow rate leads to a rise in pressure, up to a point where pressure suddenly drops (called "surge point"), and results in an aircraft stalling. Different wing types will affect the kind of engines used and vice versa. To gather data regarding the compressor map, some tools will be used: A pressure transducer or manometer to measure pressure rise, and a pitot tube with a transducer for flow rate. The pitot tube allows for the measuring of total and static pressure, and using Bernoulli's Principle and the difference between the two pressures (via the transducer), the flow speed can be found. Using the flow speed, mass flow rate can be estimated. Pressure rise is measured directly by another dedicated transducer or a manometer. The engine compressor at JHU comprises a 1.5-stage compressor, with three blade rows (IGV - Inlet Guide Veins), a rotor, and a stator. The only rotating blade row is the rotor, and the IGV's are used – from their name – to guide flow to the rotor, where the rotor works on the fluid and increases both pressure and velocity of the fluid. The stator converts excess velocity into pressure and diffusing, also guiding the flow if another rotor was present. Using this data, we would be able to analyze the different surge points or lines (if tested with multiple speeds) to determine at what pressures and flow rate a compressor would "fail."

Water Adsorption in ATP modified Metal Organic Frameworks
Murad Habtu

Mentor: Dr. Michael Tsapatsis
Supervisor: Danyu Wang
Department of Chemical and Biomolecular Engineering, Johns Hopkins University

Metal organic frameworks (MOFs) are a porous material that have uses in gas/vapor separation, gas storage, catalysis, luminescent materials, and biomedical imaging. Water adsorption could be used in different applications like water harvesting from the atmosphere. During water adsorption MOFs would absorb the water into their pores and hold it there until energy was introduced for it to be released. The amount of water pulled into the MOF is determined by the MOFs surface area. MOFs like MOF-808 have large surface areas, but are hydrophobic, so they lack recyclability in MOF water harvesters since they would become unstable or break down from the water interacting with them. The functionalization of adenosine triphosphate (ATP) into the pores of MOF-808 to prevent this breakdown and to observe the change in recyclability of MOF-808. The MOF-808 is modified with ATP and its water uptake is compared to the original MOF-808. The difference in water adsorption will determine whether ATP functionalization helps MOF-808 from becoming unstable. The hydrophobic MOF-808 is able to be used for water harvesting and allows more water to be produced when compared to a different MOF already being used with a lower surface area. Other hydrophobic MOFs that may have even larger surface areas could be modified with ATP to be used for water harvesting without becoming unstable. These results can be used to create better versions of MOF water harvesters that can produce greater amounts of water for areas that experience water scarcity.

Junior Innovation Abstracts

Machine Learning and MATLAB
Eden Rhodes

Mentor: Dr. Mingchao Cai
Department of Mathematics, Morgan State University

As we all know, the world is technologically advancing right before our eyes. Artificial intelligence, the process of giving computers human traits and abilities is becoming more prominent with the use of machine learning, giving computers human skills. Machine learning is implemented in our world in many different ways, one of these being facial recognition. From airport security to the phones we hold in our hands, facial recognition is already in widespread use. A new application of this technology is being applied to help identify and track endangered species. If computers are able to recognize endangered animals in the future, scientists will be able to easily track the long-term movement of animals in an non-invasive and accurate way. This is important for the study of animals over long periods of time. Image recognition is done with the use of convolutional neural networks. A convolutional neural network is a type of neural network that is used for facial recognition. My project aims to apply deep learning technologies to evaluate the efficiency of MATLAB toolboxes for the use of facial recognition. This will be done by using a MATLAB deep learning toolbox to create a neural network to identify animal images.

Virtual Reality and Motion Sensor: New Way to Track Proprioception
Jordany Roman Gonzalez

Mentor: Dr. Amy Bastian
Supervisor: Cristina Rossi
Kennedy Krieger Institute, Center for Movement Studies

The body's ability to track limb position and movement without relying on vision is called proprioception. This ability allows humans to navigate and interact with their environment. Proprioception can be tested by asking someone to report the perceived position of their hand after it was moved by someone else (passive) or by themselves (active). Currently, healthcare facilities test proprioception with passive tests done manually by a clinician. However, manual tests are less sensitive and more prone to human error than computerized tests. Furthermore, passive tests may be less informative than active tests about patients' performance in daily actions, as these often involve active movements. My work aims to create a new method to test active and passive proprioception using a virtual reality environment and an optical motion sensor. In the active task, subjects have to position their index finger as close as possible to a strawberry. In the passive task, an examiner places the subjects' index finger in a predetermined location, and the subjects are instructed to position the strawberry as close as possible to their finger. For both conditions the subjects' hand is invisible to them inside the headset. We then quantify the accuracy (shift and variability) of their positions and compare them to those reported in previous studies. Our novel method may provide a better tool for healthcare professionals to measure proprioception. This may improve how we track the effects of new therapies and may help clinicians to make well-informed decisions about a patient's treatment plan.

Junior Innovation Abstracts

Ransomware and its Payments in the Blockchain
Chloe Harrison

Mentor: Dr. Matthew Green
Supervisors: Gabrielle Beck and Max Zinkus
Department of Computer Science, Johns Hopkins University Whiting School of Engineering

Ransomware is a virus downloaded onto a victim's computer that demands payment in return for the user's data. These attacks can range in severity, from hundreds to millions of dollars in payments, and can attack singular victims as well as large organizations. There are multiple ways to prevent a ransomware attack, mainly through protection software and online safety procedures, however, ransomware is still a prevalent issue. In order to prevent the spread of ransomware, we can track certain payments through the blockchain to find who is behind these crimes and contribute to the current knowledge of ransomware. To assess the effectiveness of these current ransomware tracking techniques, I will be replicating a previous study. Techniques from the study, as well as my own, will be applied to the research, some techniques being cross referencing and querying the data, and building a transaction graph to follow the payments. More recent data will be used in this study, that data being gathered from the website Ransomwhere. Results of this study will help inform the general public of the dangers of ransomware, as well as providing more reliable data for even further research and future reference.

Automated Surgical Robotics and Image Analysis
Skylar Strickler

Mentor: Dr. Axel Krieger
Supervisor: Michael Kam
Laboratory for Computational Sensing and Robotics, Johns Hopkins University

Laparoscopic surgery, a surgical procedure where small incisions are made in patients body to put slim surgical tools and sensing equipment through, has been revolutionized by surgical robots that are controlled by the surgeon to be as safe as possible for the patient. Although these robots are safer, some surgical tasks became tedious such as suturing or stitches. The Smart Tissue Anastomosis Robot (STAR) was developed by Johns Hopkins Intelligent Medical Robotic Systems and Equipment Lab. The STAR was designed to perform suturing tasks autonomously. It was shown to outperform other standard surgical techniques. My project focuses on one flaw with this robot, the camera placement. Currently the camera is located at a diagonal angle attached away from the suturing tool. This angled camera can cause the robot to receive inaccurate data making the STAR not perform at max efficiency. To solve this problem the camera needs to be relocated directly into the suturing tool so that the STAR has a clear and accurate view for image analysis. To fix this problem I first designed and set up a smaller scale version of the STAR's camera control. The system consists of an arduino UNO as a master and a servo motor with a webcam attached to it. The system is tested using a piece of paper with a line drawn on attached to a harvard pump to move the paper. Using MATLAB to create an edge detection algorithm I was successfully able to track the moving line in real time keeping the line centered in the image. My results show the effectiveness of a frontal view of the operation area instead of an angled view.

Junior Innovation Abstracts

COVID-19, Anomie, and Fear of Crime
Frebruk Mikre

Mentor: Dr. Nicole Shoenberger
Department of Sociology, Loyola University Maryland

COVID-19 has drastically altered the social state of the country and as a result, mental health, stability, and satisfaction have gone into disarray. Durkheim postulated that the actions and social interactions of the individual were dependent on the social structure that regulate the society one lives in. Drastic change in that social structure has been known to cause significant discomfort and dissatisfaction of the individual, especially when that change happens swiftly. My research focuses on how the rapid change in social norms and otherwise lack of norms affected the perception and fear of crime as well as the levels of anomie in the US. My analysis will be done on a dataset collected by my mentor that received survey responses nationwide asking about different self-assessments of one's own opinion and experiences during the pandemic. A few questions are formatted as a scale to be able to analyze as such. I will be analyzing these scales as well as the correlations between demographics and the prompts pertaining to my overarching question: How do age and other demographics factor into the overall fear and perception of crime during COVID-19? The implication of the results include a more comprehensive understanding of the effect of the COVID-19 pandemic on society's well-being as well as a significant addition to the large catalog of conclusions, claims, and postulates about fear of crime and anomie. Because of the conjectural nature of anomie and fear of crime, the only way we have currently to gain understanding about their implications on society is to essentially brute force our understanding by conducting as many studies and analyzing as much data as possible.

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 on the Symposium website represent a first effort to present their research topics to a public audience.

Solitary Confinement's Effects on Mental Health
Leo Boehringer

My research is focused on solitary confinement methodology and the connection between the isolation and sensory deprivation of prisoners and developed mental health issues. I encountered a study on prisoners questioned using neuropsychiatric interviews at intake, and three years after intake after being placed in solitary confinement. Researchers found that the prevalence of mental health issues, such as major depression and psychosis, increased from intake to follow-up.Another study examined how the brain's structure deteriorates after a prisoner experiences sensory deprivation. Researchers found that prisoners often experienced a decrease in brain functionality when exposed to heavy levels of sensory deprivation in solitary confinement. This research is vital to studying the impacts of solitary confinement on mental health. This research can be used to help improve public health and methods we have to treat mental and physical health. I will be continuing with Research practicum and hope to find a mentor in the field of psychology, mental health, astrology, or earth sciences to expand my knowledge.

How Public Green Spaces in Urban Environments Can Improve Peoples' Health
Ava Pevsner

The environment that people live, work, and exist in can tremendously affect their mental and physical health. Specifically, there is a link between proximity and availability of green space and public health patterns in urban environments. My research focused on what specific negative effects lower levels of green space have on public health, and the factors that lead to these effects being exemplified in certain communities. This issue ties into the STEM field of environmental engineering, as some solutions to this issue involve urban planning in a way that provides green spaces for a larger population. A particular study found that repurposing empty lots and unused spaces into public green spaces can have a significant impact on the sustainability of a community. The effects are also linked to epidemiology, since patterns in the health effects from a lack of green spaces can be studied in order to get to the root of the issue and trace solutions. I plan to pursue the Ingenuity Research Practicum and study in the field of neuroscience.

Sophomore Interest Statements

How the Lack of Childcare Affects the Physical and Mental Wellbeing of Mothers and Their Children
Maria Chen

Childcare is a necessity for many new and working parents. A lack thereof has negative effects on parents and their child's well-being. Many working mothers who fail to secure childcare placements will often face the difficult choice of pursuing their career or being a mother. My project looked at how multiple unstable childcare arrangements can lead to child development and behavior problems. For example, one study I examined found that as the number of childcare arrangements a child experienced between birth and age 3 increased, the more parent-reported externalizing behaviors, like aggression and yelling, children showcased. Other studies examined how a mother's stress exposure, including a lack of social support and childcare, affects their brain responses to infant cry. Results found that increases in maternal stressors led to a reduced brain response to infant cry in several brain regions, including the right inferior frontal gyrus and superior temporal gyrus. This further signaled lower maternal sensitivity in parent-child interactions. The implications of this research are critical in helping women thrive in both their careers and in motherhood. Helping these mothers balance their responsibilities allows more women to be in the workplace, thus promoting a more diverse and representative workforce that allows more voices to be heard. I will be continuing with the Research Practicum at Johns Hopkins University, Department of Chemical and Biomolecular Engineering, under Dr. Efie Kokkoli to study the uses of DNA nanotechnology for targeted cancer treatments.

Ecohealth is Mental Health: How We Can Combat The Mental Health Decline Due to Air Pollution
Camille Coffey

My research is about the negative effects of air-based contamination on the mental health of the public. Mental health issues and environmental pollution, both major social problems, are now dangerously intersecting and leading to higher levels of cognition issues, anxiety, depression, and stress among adult and child populations. The field of neuroscience can help solve this issue by allowing us to study the brains of individuals exposed to high levels of air pollution. In one paper I reviewed, researchers considered how the use of neuro-scanning technology can explain the effects of exposure to air pollutants on cognitive processing abilities. Ecology and environmental science can also help with solving this issue by showing us how public green spaces can assist in combating air pollution and mental health decline simultaneously. Ecological studies explain how urban green spaces can remove particulate matter and increase air quality. Green spaces have also been shown to significantly help people's mental health and emotional wellbeing. The research presented in this project could be useful for making urban environments more climate-friendly and beneficial for the mental health of citizens. I am pursuing the Ingenuity Research Practicum and working with Dr. Steven Farber to investigate marine biology and biochemistry.

Sophomore Interest Statements

Working to Eliminate Bias in Predictive Policing
Madison A Drummond

My project examines bias in the criminal justice system, specifically in predictive policing. Predictive policing uses computer algorithms to better inform law enforcement on a variety of subjects. For example, COMPAS is a policing program used to predict the likelihood that a defendant will reoffend. This topic is important because many algorithms are made in a way that disproportionately or wrongfully targets people of color. My first STEM application is math/statistics, which looks at how biased statistics lead to bias in algorithms. For example, one study found that some police officers are dishonest when writing their reports. They had a tendency to falsely report someone's race in stops that did not result in charges as white. As a result, some officers might be less inclined to target white people, since they routinely see people of color reported in crimes by fellow officers. My second STEM application is machine learning which looks at the creation of biased algorithms. Since algorithms are created with the help of human input, people are indirectly teaching the computer their own biases. My research will work to find ways to eliminate bias in predictive policing in order to improve these systems. I hope that all people will be able to have the same trust in their criminal justice system in making fair decisions. I will be pursuing the Ingenuity research practicum and hope to find a lab that focuses on microbiology, molecular biology, microphysics, or genetics.

How Transgenerational Trauma Effects the Biological Makeup of the Brain and Future Generations
Jhamari England

Trauma experienced during childhood can have lasting effects throughout a person's life. Based on one study, adults with traumatic histories are more likely to be on two or more psychotropic medications, have a chronic health condition, deal with anxiety, or have lower self-reported health. Parents can unintentionally pass their trauma down to their children. A key aspect of transferring trauma to descendants is familial communication. For example, Aboriginal people lacked the knowledge on how to raise children because of their lack of a healthy paternal role. After they were removed from their households and placed in provincial care, they felt a lack of belonging with their identity and community; isolated from their caregivers; encountered substance misuse and abuse; experienced an inability to maintain intimate relationships; had involvements with the criminal justice system along with the mental health system. These characteristics remained with them as they grew older and became parents to their own children, passing down those inherited behaviors. Epigenetic mechanisms are also a vehicle for intergenerational transmission. Children born to holocaust survivors were so affected by their parents that they exhibited behavior as if they were in the Holocaust themselves. These individuals also demonstrated changes in neuroendocrine markers similar to people with Post traumatic stress disorder (PTSD). This research is imperative in understanding how subsequent generations inherit historical traits from their family member's trauma. I plan to pursue more research findings on the causal relationship of trauma on RNA and DNA through the Ingenuity's Research Practicum at Johns Hopkins University under Dr. Sabunciyan.

Sophomore Interest Statements

Human Overpopulation and the Effects on Most Aspects of Life
Reid Glaros

Overpopulation greatly affects the world, from the economy to the habitats of local wildlife; because of this, it is an important problem that needs to be researched. One STEM discipline that can be used to help address this problem is statistics, which sheds light on patterns that may cause overpopulation, as well as factors that are most affected. An example of this was shown in a study conducted across Chinese cities where it was found that places with high population density tend to have a higher obesity rate in middle-aged adults than in less densely populated areas. These results were found through a statistical analysis of data collected on multiple different variables. A second STEM application that could be used to address the problem of overpopulation is ecology, which is the study of the relationships between organisms. It can be a powerful tool to find out how human populations affect the environment and the individuals within the population. One example study with a focus on ecology found a relationship between child height/infant mortality rates and open defecation, with the cause of high open defecation levels being high population densities. My project brings the opportunity to better understand the effects of our present occupation of the planet and the continuously growing population levels on the world around us and our own health. I am pursuing the Ingenuity Innovation Practicum with a possible mentorship at T. Rowe Price under Nathan Henkle.

The Impacts of Racism on Black Women's Maternal Health
Ellen Griffin

Disparities in maternal healthcare, including increased maternal and infant mortality and morbidity rates for Black women, stem from the history of racism. One STEM field vital in understanding the underlying sources of the racial maternal disparities is biology. Racism is a stressor that often results in complex trauma, and when combined with the life stress of being a woman, a Black woman's mental health is significantly damaged. The biological impacts of chronic stress leads to declines in physical health that puts them at a disadvantage, especially in maternal and cardiovascular health. A paper I read discussed the weathering theory, which states that the chronic stress of being a Black woman in America biologically "ages" them up, resulting in issues regarding maternal health that would typically be present in women later in life. Statistics also explain the disparities in healthcare because they provide data to show inequalities, and show the historical context of racism as a determinant, leading to healthcare disparities. Another article I read showed that Black women are often neglected in their maternal healthcare, which has roots in stereotypes of Jezebel and Sapphire and the distrust between patient and provider from the basis of maternal healthcare. By further investigating causes of maternal disparities, we can address the often overlooked factors that cause many issues, not only for disparities in Black maternal health, but also in the general lives of Black people in America. I am pursuing the Ingenuity Research Practicum and hope to work in bioengineering.

Sophomore Interest Statements

Climate Change: Challenges Facing Coastal Communities of Color
Lavender Hall

As our climate changes, multiple environments and ecosystems are disproportionately impacted by its effects, most of them being sustained and inhabited by communities of color. Additionally, many coastal communities belong to people of color, and they are seeing the impacts of climate change much faster than other areas. Climate change puts many parts of coastal environments at risk with coral bleaching, high acidity, increased temperatures and more. These communities heavily rely on coral reefs as a food source, since it is a home, breeding ground, and nursery for many of the seafood belonging to their diets, as well as to protect coasts with wave reduction and to attract tourists. Studying environmental racism allows us to know what parts of climate change to fight first, helping us find solutions to address the needs of marginalized groups. My project uses research from the topics of marine biology, environmental science, and oceanography to analyze some of the issues that will destroy these communities. For much of my research, I want to study the impacts of climate change on coral reefs and the physical advantages of coral reefs on coasts, as well as the impacts overexploitation of resources can have on populations. One article I examined discussed how overfishing alters the balance of ecosystems, causing a shift from coral dominance to algae, harming ecosystems. Another article described research studying wave dissipation in areas with coral reefs, showing that in areas where reefs were present (within the area they studied), wave heights in certain depths were reduced by 97%. Oceanographic studies like this one allow us to analyze what needs to happen and how to protect waters around these communities. My research shows many of the environmental threats especially impact communities of color. By displaying these effects, we can redirect our advocacy of environmental issues, and associate them with the impacted people. My goal is to pursue the Ingenuity Research Practicum in the field of marine biology or aquaculture to study more of the impacts of climate change and sustainable ways to solve them.

Cultural Healthcare Misconceptions and Their Implication on Patient Care in Hospitals
Zoë Hong

Healthcare is a service that has existed for centuries, built on trust between a giver and a receiver. When this bond breaks, it becomes difficult to help others consent to a form of treatment that they may not understand. Scientists have found ways to help healthcare professionals understand patients who have apprehension about their treatment methods. Professionals, like everyone else, have implicit biases stemming from the structures of their brains, causing intolerance directed to the uninformed. A study found that prejudice scores may decrease after repetitive stimulation to the brain, meaning that there is a way to remedy the historical bias that has been in society for centuries. Understanding the historical evolution of implicit biases within cultural contexts is crucial to changing bias-related problems today. Another study investigated CART, a machine learning model that can predict the level of impact of an intervention based on a given set of values. By using such techniques, CART can match ideal treatments with people. Though it is crucial to allow people to believe what they wish, sometimes their socio-cultural identities overwhelm their perceptions towards diseases. Cultural beliefs build a mental framework within patients, influencing their actions towards preventing disease and seeking healthcare. If healthcare workers can expand their perspectives, they can take the time to educate patients about basic preventative measures and medicines. I will be a part of the Ingenuity Research Practicum, and I hope to learn more about the biomedical field.

Sophomore Interest Statements

How Intention and Technology Can Curb the Opioid Epidemic
Vladimir Gapeev

Drug overdose has become one of the most significant non-age related causes of death with just around 100 deaths per day in the United States alone, almost matching car crashes with approximately 108 deaths a day. A little more than a third of overdoses (38 per day) are from prescription opioids. Opioids are by far the biggest contributor to drug overdoses and need to be controlled as this contribution has only been growing in recent years. An important field in the study of opioid-related deaths is chemical engineering. It is important to know how these drugs affect the brain in order to make them less addictive. For example, the field of chemical engineering can help curb the opioid epidemic by offering intentional design to painkillers and drugs. It is possible to make less addictive, albeit effective drugs in order to attempt to limit addiction. Another important field to consider when talking about opioids is neuroscience. Neuroscience offers solutions to the consumer part of addiction rather than the supplying part as chemical engineering might. For example, neuroscience can help us understand how to make more efficient tests to see who has been using opioids recently in order to prescribe appropriate treatment. The most important thing to take away from this project is that addiction is not black and white, but instead a spectrum with a web of causes and effects, spanning every part of life. I intend to complete Ingenuity's Research Practicum and complete research in the field of biomolecular engineering and/or medicinal chemistry.

Microplastic Exposure Stifles the Growth and Development of Marine Life
Brandon Isbell

Microplastics, defined as plastic particles less than 10 millimeters in size, are widespread aquatic pollutants that inhibit the growth and development of marine life, especially microorganisms like plankton. Because the concentrations of microplastics in bodies of water continue to increase, the need to protect aquatic ecosystems has become increasingly apparent. Marine ecotoxicology provides a greater understanding of the problem. Microplastics are known to easily absorb chemical contaminants and heavy metals, which can worsen their already devastating impact on the health of marine life. Furthermore, these harmful chemicals may desorb once consumed by aquatic organisms. One study explored how clams fared when exposed to chemically contaminated microplastics and sterile microplastics. Both types of microplastics induced oxidative and DNA damage in the sampled clams. However, the damage caused by the contaminated microplastics was vastly more severe. Another scientific field which helps to explain the problem is marine biology. Marine biologists have found that microplastic consumption can reduce the growth and reproduction of marine microorganisms. One such study estimated that microplastic exposure at environmentally realistic concentrations would lead to a 30-fold decrease yearly in the population of a marine copepod. Such a drastic population decline would devastate aquatic ecosystems. Therefore, the implications of microplastic contamination have far-reaching consequences and will require swift and substantial action. Because all ecosystems depend on each other, this problem affects all organisms, including humans. In the future, I will be working with Dr. Gordus in the Department of Biology at Johns Hopkins University as part of Ingenuity's research practicum.

Sophomore Interest Statements

Hydrogen Cars and 4D Printing for Consumer-Based Pollution Reduction
Louis Lapp

Air and material pollution pose a substantial threat to human populations and global ecosystems alike. Plastic fluxes from landfills through various marine catchments, inducing prolonged ecosystem degradation and irrecoverable material loss. ICEVs (internal combustion engine vehicles) emit carbon dioxide and other toxic air pollutants, contributing to climate change and respiratory health concerns. Using engineering and chemistry, FCEVs (fuel-cell electric vehicles) and hydrogen production systems eliminate carbon emissions through minimizing transportation and undergoing carbon-free chemical reactions. For example, onsite wind-powered hydrogen production employs electrolyzers to convert water to hydrogen fuel which is subsequently stored at high-pressure to maximize storage capacity. Next, 4D printing filaments apply chemistry to bond photo-crosslinked monomers to active sites on polyimide chain segments under ultraviolet radiation. Material selection and fabrication techniques yield a recyclable, durable, and flexible material designed to adapt with environmental stimuli (such as heat, water, or electricity) for a prolonged lifecycle and afterlife material recovery. There is considerable potential for FCEVs and 4D printing to transform our lives as consumers. For instance, FCEVs are a strong alternative to BEVs (battery electric vehicles) in the push for green vehicles thanks to faster fueling and superior range. The recyclability, adaptability, and efficiency of 4D-printed objects also implies this technology could emerge in numerous consumer-related industries, such as packaging. When adopted, these technologies could drastically reduce individual consumer air and material pollution outputs as the world advances towards a sustainable future. I will be pursuing Ingenuity's Research Practicum to better understand computational engineering and environmental sciences.

The Effect of Gender on Mental Health
Eliza Mckenna

In the society we have created, sex can completely decide the trajectory of a person's life. With someone's entire future being decided by an "x" vs a "y" chromosome. I wanted to learn about the effects of this by researching the impact of sex on a person's mental health. Mental health is a very relevant problem and anything we can study which would possibly be able to predict or find solutions could offer help to people around the world. The genetics of mental illnesses can offer a lot of insight on this problem. In a study on the genetics of eating disorders I learned how closely different mental illnesses are linked, with certain illnesses being able to predict the likeliness of others. It was also important to note the large role a person's personality plays in the likelihood of experiencing eating disorders as personality is influenced so much by gender. We can also learn about this problem through the neuroscience of sex. Brain studies showed that a person's femininity or masculinity levels would be able to predict the amount of gray/white matter inside the brain. With gray and white matter both having large personality impacts, it is seen that there is a neurological difference between men and women which could lead back to mental health problems. This research can help in predicting mental illnesses and in learning the importance of creating a world where gender is less limiting. In my further research, I hope to learn about genetics and its effects on growth and development.

Sophomore Interest Statements

Heat Waves and Their Effects on Agriculture and Health
Kei Leigh Mese-Jones

One of the most noticeable effects of climate change has been the increase in temperature, accompanied by an uptick in the occurrence and severity of heat waves. My project utilizes the health and agricultural fields to explain and mitigate the effects of heat waves on human health and farming. One study done in the agricultural field showed that rice cultivars with higher levels of photorespiration regulating enzymes led to more stable photosynthesis levels , which increased the level of heat tolerance. This knowledge could later be used to cultivate more heat-tolerant forms of rice. Another study, conducted in the medical field, showed that temperature increases in California have led to increased cardiovascular and respiratory related hospital visits, and that areas with increased ownership rates of AC units had a lower rate of these occurrences. Knowing this correlation between AC unit ownership and hospital visits can help to prioritize the development of less expensive, more energy efficient AC units. I will be pursuing the Ingenuity Research Practicum and working with Dr. Emmy Smith in the Department of Earth and Planetary Science at Johns Hopkins University.

How Statistics and Neuroscience can Make People Believe in Science
Miya Mese-Jones

The disbelief and mistrust of science and scientists is a problem that delays the effects of new ideas and innovations that help people and the Earth. Statistics and neuroscience are both important fields when thinking of this problem. The analysis and presentation of any kind of scientific data can be greatly improved to better help the general population understand important situations like the scientific community does so they can appropriately react, so it's important for scientists to present data that is easy to understand. In a study with 690 women on how they perceived tailored breast cancer statistics, it was shown that people are more likely to believe risk numbers if they were shown how they were calculated because they understood where the diagnosis was coming from. The relations of genetics and politics and other ways of thinking are also important in helping solve the problem of people not believing in science. Another study showed that brainwave oscillations, which influence the way humans think, are genetic. It was found that many beliefs people have are innate, which helps neuroscientists understand where different ways of thinking come from, and what opinions are from nature and what are from nurture. If we know that, we can better portray statistics so people with different opinions can understand them. New findings and ideas only work if everyone is on board. For my research practicum, I will be mentored by Dr. Axel Krieger from the Department of Mechanical Engineering at Johns Hopkins University.

Sophomore Interest Statements

Using Botany, Chemistry, and Physics to Mitigate Rising Temperatures and Air Pollution
Maya Molina

I am researching environmental racism and its effect on people's health, specifically regarding air pollution and heat exposure. People of color, and Black people in particular, are more likely to live near sites emitting air pollutants and in neighborhoods with higher temperatures. Heat mortality and air pollution cause health problems specifically but also exacerbate existing conditions. I researched two solutions to these problems. First, botany and chemistry can be used to improve air quality by creating biofilters. These are filters that use live plants or compost material to remove air pollutants from the environment. A study that researched the effects of using an active botanical biofilter to remove pollutants emitted from nearby busy roads found that the filter could remove around 76% of Nitrogen dioxide with just one pass through the filter. For heat mortality, chemistry and physics can help create cool roofs. Cool roofs have an increased albedo, causing them to reflect more of the sun's radiation to help mitigate the rising temperatures in cities. One study found that during a heat wave, cool roofs could prevent 25% of heat related deaths. Further research could be done on how cool roofs could help offset warming caused by climate change, or the impact of implementing these solutions where they are needed most. I will continue researching how plants interact with their environment for my practicum. I will be mentored by Dr. Meghan Avolio from the Department of Earth and Planetary Sciences at John Hopkins University.

How Social Media Affects the Mental Health of Adolescents
Amelia Overton

Social media can affect the mental health of adolescents in negative ways. Adolescents who use social media are at risk for threats, harassment, and cyberbullying which can lead to a lack of self-confidence, lack of interest in reality, aggressiveness, and a decrease in quality of life. This problem is becoming more prominent in today's society because of the increased use of social media and phones by adolescents. Neurology helps explain this problem because social media involves and stimulates the brain which can lead to changes in the behavior of adolescents including the inability to form long-term relationships which leads them to become more isolated from reality. The computer science behind social media apps is also very relevant in the explanation of why this problem is present. For example, the like button, which is a binary like/dislike format, creates a platform with much social feedback. This feedback keeps people engaged and makes the app very addictive. Research on social media impacts can make people more aware of the effects social media has on them and it might encourage people to step away from their phones and try to create better relationships with people in their lives. This research can encourage someone to step away from social media and focus on their own life and happiness and make them more aware of how they are being affected by social media. I plan to pursue the Ingenuity Research Practicum and work in the field of environmental health and engineering.

Sophomore Interest Statements

Studying the effects of climate change and the drastic effects on humans
Krrish Shrestha

My research topic is focused on the effects of climate change on living things on the planet. It is crucial to study this topic because it will influence future generations. Climate change will affect everyone if it isn't dealt with sooner or later. There are many problems climate change brings, but some of them can be fatal to humans. One of them is heat related deaths. Looking back to one of the articles I read, researchers predicted that by 2100 there would be a drastic increase in heat related deaths. The number could probably increase more since many countries might not have resources like air conditioning The overheating of our planet will also cause other disasters too. Things like more powerful storms, hurricanes, and more tornados. Because our planet is warming up, it also causes the sea surface to warm up. This causes a direct impact on storms, hurricanes, etc. since many of them are caused by warm mixing with cold. Due to increased power, many countries will suffer losses, and most likely many fatalities. By understanding how greenhouse gasses are heating up the planet, we can hopefully find a solution to our overheating planet. I am going to do the innovation practicum and am interested in computer science.

How Biology and Statistics Help Explain the Gender Divide in Sports
Ruby Polansky

My research is focused on understanding how biological differences between women and men play a role in gender inequalities in sport. Also, I examine how pay statistics offer additional understanding of this gap. My work looks at how this gap has changed over time and concludes with suggestions on how to promote more equality. I specifically examined the ranges in biological advantages and disadvantages women have in specific sports. For example, men have a higher percentage of muscle mass in their upper body which results in a larger amount of power production than women during upper body exercises such as swimming. When looking into the gap in pay statistics I found that in professional hockey, men get paid on average 2.69 million dollars compared to women's $10,000 - $26,000 for the same job. The research presented in my project can help us understand the distance we have come, and the growth we still need in order to reach gender equality in sports. I will be continuing with Research Practicum likely in the field of neuroscience specifically cognitive functions. I hope to look into how people react to different stimuli in their environment.

Sophomore Interest Statements

How Alternatives to Traditional Chemical Pesticides can Reduce Pollution
Stephenie Providence

My research builds upon a bigger picture of the detrimental effects of common chemical pesticides on our environment and public health while taking a deep dive into positive alternatives. Public health and the future of our planet are at stake, making this topic especially relevant. Biochemistry is an important field of study that is heavily linked to the topic of my investigation. One study explained the effects of popular pesticides on the human body, specifically how these chemicals disrupt normal chemical processes. For example, Organophosphate insecticides are known for causing a buildup of acetylcholine and hyperstimulation cholinergic receptors. Acetylcholine is responsible for controlling secretion, slowing your heartbeat, and contracting smooth muscles. Cholinergic receptors are activated after binding to acetylcholine and once bonded are responsible for slowing the heartbeat. Entomology also plays a part in identifying causes for high pest populations, what keeps them high, and what could lower them. A study looked into trials comparing the effects of the presence of natural predators versus their absence in an isolated environment. Then, they did trials with pesticides and without pesticides, including trials that combined the effects of natural predators and pesticides. Finding alternatives to toxic pesticides has a huge impact on all of us because the more work that is put towards development of cleaner methods the more likely it is that these methods will become common. This means that there will be less of a need for pesticides that harm the environment which will be beneficial for everyone. I am pursuing Research Practicum and will be mentored by Dr. Peter Devretos from the Department of Cell Biology at Johns Hopkins University.

Mental Health Challenges in Minority Communities
Cecelia Reichelt

Minority communities display a disproportionately high rate of mental health disparities. Minorities experience systemic racism, which impacts their access to diagnostic resources and treatments for mental health problems. This is important to study, because racial minorities experience additional stressors compared to white people. These stressors can evolve into significant problems, such as psychosis. Psychosis is mental disturbance, when a person's understanding of reality is altered. One STEM application that can help better understand this problem is neuroscience and cognitive thinking. One study found that psychotic disorders are positively linked to cognitive dysfunction; cognitive dysfunction tends to impact minority communities more than others. Another STEM application is the biopsychosocial model. Scientists found that biopsychosocial models look into mental health diagnoses and treatments based on race and ethnicity. Mental health challenges were examined through three different lenses; biological, psychological, and social. This new perspective looks into neuroscience along with social sciences to explain mental health disparities. This research can have a huge impact on millions of people's lives, and more people can be treated for specific mental health problems. It will open up a new discussion on mental health in our everyday lives. This research is different from my lab research, but I plan to pursue Ingenuity's Research Practicum and work in a marine biology and watershed preservation lab Dr. Eric Schott at IMET.

Sophomore Interest Statements

How Virtual Reality and Neuroscience Can Be Used to Study and Treat PTSD and Drug Use from Trauma

Penelope Schenkel

My research studied the effect of childhood sexual abuse (CSA) on substance use later in life. Many people who experience CSA have lifelong trauma, resulting in poor mental health. Additionally, I researched how virtual reality exposure therapy (VRET) can serve as treatment for people diagnosed with PTSD. Researching methods of therapy for those who have undergone trauma and investigating how this trauma correlates with substance abuse is important because it is crucial to understand and develop ways to aid those who have experienced trauma and improve their quality of life. Adolescents, veterans, and young children alike undergo trauma that requires attention before it becomes a larger issue. Neuroscience helps explain the neurobiological effects of drugs on the adolescent brain. Adolescents who experience CSA are more likely to abuse drugs than those who do not, making it imperative to research the possible deficiencies drug usage at an earlier age can cause. Computer science is being used to treat PTSD symptoms in veterans, with recent studies showing positive results. VRET shows potential specifically in those resistant to traditional therapy, as it allows for greater activation of the traumatic memory. The research presented in my project displays current knowledge about the impacts of drugs on the adolescent brain in addition to stressing the need for more research about VRET, which has potential to aid many whose daily lives are impacted by PTSD. I will be pursuing the Research Practicum with Dr. Jacky Jennings, studying epidemiology and public health in Baltimore City.

Mass Incarceration's Effect of Black Women's Health

Margaret Schmitz

My research focused on understanding the effects that black women feel from Mass Incarceration. Often when people think of Mass Incarceration, they think of the targeting of black men. Thus, the effects of it on black women is often overlooked. Black women's experience is worsened by their experience with both racism and sexism, and their proximity to incarcerated people. I used the STEM application of statistics to help better understand their experience. Since 1980, the number of incarcerated women has increased by over 600%. Black women are statistically more likely to be incarcerated than any other race of women, and currently incarcerated or previously incarcerated people are statistically more likely to experience mental illnesses throughout their lifetime. This means that a disproportionate number of black women experience mental illness due to being incarcerated. They are also more likely to be in close proximity with someone who is incarcerated, which can affect their maternal health. My second STEM application was neuroscience, where I tried to get a better understanding of how anxiety and depression manifest themselves in the brain and how this in turn causes incarcerated black women to have mental health issues. Much of the current understanding of mental illness is based on false hypotheses. Hopefully there will be great headway in this area to help more vulnerable populations like black women. I plan to pursue Ingenuity Research Practicum and find a mentor in the Department of Neuroscience at Johns Hopkins University.

Sophomore Interest Statements

Reducing and Reusing Industrial Pollutants Through Reinvented Processes
Anson Stine

My research is focused on reducing and reusing industrial pollutants through engineering and chemistry. Industrial pollutants include sulfur dioxide, black carbon, and various stone contaminated wastes called slag. They may aid in wrecking ecosystems and negatively harming the health of those living in close proximity to polluting facilities. Inversely, they may add a societal benefit to infrastructure. The pollutants that industrial plants have not been able to apply beneficial usages to, have instead had methods invented to remove them. One study that I examined found that using eucalyptus bark to soak up chromium polluted in industrial bodies of water was an effective method that limited pollution up to 99%. Another study examined batik dying, which is a process where wax is dyed with artificial materials and has parts of the cloth covered in wax to avoid the dyes. By switching artificial dyes for natural ones, the study found that the oxygen demand of polluted water could be reduced upwards of 85-98%. In other studies, researchers found they could include pollutants into cement, which increased the compressive and flexural strength of the pollutant-filled concrete. The effects of this research can help reduce the rising temperature rates of our planet and improve the health of nearly all organisms currently affected by these industrial processes. I am continuing the Research Practicum at the Johns Hopkins School of Medicine under Dr. Kathleen Cullen to study the various components of the vestibular system.

The Radical Agenda: Automation as the solution to the prevalence and prevention of Antivax fake news
Josh Daniel Tagle

Major media platforms that fail to identify misleading and divisive content have physically and ideologically split our communities. Whether our attention is turned to claims of a fraudulent election campaign or inappropriate celebrity action, the impacts of these messages continue to exert a stronger influence with the rising relevance of the pandemic's struggle for accurate information. This biased system introduces a vocal misrepresentation of the minority belief, which results in an exaggeration of how popular an opinion truly is among platforms. Quantitative information of resultant behavioral consequences means obtaining a complete understanding of our pathos' neurological manipulation. Patterns of hippocampal molecular disorder in response to stimuli indicate that there is a higher retention of information when an event occurs with a greater frequency than expected. Such responses provide an incentive for creators of fake news to advertise interesting yet misleading content. Because of the overwhelming accessibility to online spaces plagued with malicious media, the exposure of harmful information to an extensive audience can be limited by inerrable technology. Computer scientists can easily collaborate linguistic parameters to perfect these algorithms, with pre-trained lexical programs identifying fake news with over 0.93 accuracy. Researchers and activists are developing scalable automations to immediately flag and remove content intended to harm, making the internet a safer place for everyone. I will be completing the Ingenuity's Research Practicum and working with Dr. Massimo Robberto at the Space Telescope Science Institute at the Johns Hopkins University. I hope to learn about astrophysics research and will focus on chaotic stellar formation in the Orion Nebula.

Sophomore Interest Statements

How Neuroscience and Statistics help explain and prevent Adverse Childhood Experiences
Bowen Valery

Adverse Childhood Experiences (ACE's) are traumatic events that occur during one's childhood that can have lasting effects on people's mental health, such as depression and anxiety. Probability, statistics, and neuroscience can help us understand patterns and risk factors of those who experienced trauma as a child. For instance, one study used a Behavioral Risk Factor Surveillance System Analysis and found correlations between household drug abuse and mental illnesses, most notably depression. It was also found that non-Hispanic black people and Hispanic people have a higher likelihood of experiencing ACEs including household drug abuse, parental separation, incarceration history at home, and parental intimate partner violence. This demonstrates a correlation between race/ethnicity and ACEs. Another study, focusing on neuroscience, concluded that infant brain development can be attributed to different aspects of their environment and the sensory information they take in. ACEs may have affected their environment and prohibited proper brain development. ACEs are a large social problem that impacts almost everybody's lives either directly or indirectly through a friend or family member. I will be pursuing Ingenuity's Research Practicum, working with Dr. Robert Leheny, from the Department of Physics and Astronomy at Johns Hopkins University.

The Effect of Air Pollution on the Brain
Charlie Vey

Exposure to concentrated levels of air pollution has shown a clear connection to cognitive disabilities and mental disorders. One study I explored followed children in Boston, New York, and Mexico City, and found a clear correlation between higher concentrations of air pollutants with neuroinflammation, anxiety disorders, attention deficit disorders, poor cognitive ability, and neurodegenerative disorders. We can also better understand this issue by researching ways to mitigate the effects of air pollution. One particular study showed the connection between green spaces, vegetation, and the absorption of air pollutants, reducing the levels of particulate matter in the atmosphere. This research is crucial for understanding the public health issues that derive from exposure to air pollution in our environment, and serves to impact global policy. In the near future, I will be completing my research practicum with Dr. Maya Gomes from the Department of Earth and Planetary Sciences at Johns Hopkins University.

Sophomore Interest Statements

How Artificial Intelligence Can Help Reduce Crime
Zari Wheeler

My research looks at how artificial intelligence can be used to predict crime. Methods of identifying and preventing crime have changed over the years, which makes the older technologies less effective. I researched different computer science options that can be applied to crime prevention. I also explored the ways crime statistics can affect current policing methods. When looking at machine learning, one type investigators can use for crime prevention is supervised learning, an algorithm that learns from input-output pairs given by the user. A supervised learning system actively used in solving crimes today is called face matching and retrieval. That is when the machine is taught various facial poses and expressions to match suspects from forensic sketches. Police can use statistics to find who is most susceptible to crimes. However, problems such as measurement issues in official surveys and overall measurement errors can lead to unhelpful data. From the research presented in this project, different methods of crime prevention can be enacted that could help save lives and contribute to safer communities. To further study biology and chemistry, I will be pursuing the Ingenuity Research Practicum. My mentor is Dr. Daniel Reich from the Department of Physics and Astronomy at Johns Hopkins University.

Using Chemistry and Engineering to Understand and Address Ghost Fishing
Jackson Dungee

One of the most prevalent dangers threatening marine environments is abandoned or lost fishing gear, such as nets and traps, otherwise known as ghost fishing gear. Abandoned fishing gear can wreak havoc on marine ecosystems, as it can trap and kill marine wildlife, and cause damage to vital marine habitats such as coral reefs and kelp forests. There are already many possible solutions that have been developed, or are in development to combat the impacts of ghost fishing gear. Most of these solutions stem from the fields of marine biology, chemistry, and engineering. For example, I looked at a study where researchers utilized chemistry to engineer biodegradable drift nets, which degrade after being submerged for a period of time. This offers a possible alternative to the common synthetic fishing nets, which are a major contributor to ghost fishing gear. In another study, engineers examined the possibility of tracking fishing gears, which would make it much easier to locate and remove derelict fishing gear from the ocean. If we are able to develop more sustainable methods of large-scale fishing, then the lives of countless marine habitats and organisms could be saved. I am pursuing Ingenuity's Research Practicum to further explore the fields of marine, micro, and environmental biology with Dr. Allen Place at the Institute of Marine and Environmental Technology

Sophomore Innovation Interest Statements

How Geo-engineering and Aerospace can Help Alleviate the Effects of Climate Change
Levi Clark

Climate change is an ever-going process. The permanent effects that occur as a result of climate change are rising temperatures, which cause many damaging effects. This paper will examine research from geoengineering and aerospace engineers to help understand and potentially solve problems associated with climate change. Heat is generated as a result of the techniques needed to cut and create aerospace equipment. One study found that mixing a carbon dioxide coolant with a type of lubricant resulted in it lasting longer than liquid emulsion and was found to not affect the ozone layer. Geoengineering is the manipulation of the environment to help combat climate change. This provides various solutions, such as sunshade engineering, which has many mirrors that reflect incoming radiation into our atmosphere, thus preventing warming in the upper atmosphere and mitigating the effects of global warming. Research done to help solve or prevent climate change has a very big impact on future generations' lives since this is a long-term problem. However, we need to start now in order to ensure that the problem does not grow much larger. I hope to be researching electrical engineering at Johns Hopkins University with Dr. Pedro Irazoqui. I aim to learn about the processes and procedures of working in a real lab and expand my knowledge of electrical engineering.

The Various Factors Contributing to Vaccine Hesitancy and How We Can Combat Them
Alexander Dickens

Vaccine hesitancy is currently one of the biggest health threats in the world. In light of the COVID-19 pandemic, it is imperative that people get vaccinated. However, many people, for various reasons, refuse to get vaccinated. As a result, preventable viruses spread more than they otherwise would be able to, leading to more deaths, long-term injuries, and stress on our healthcare system. This project analyzes medical science and data science to determine some of the most effective ways to vaccinate as many people as possible and minimize vaccine hesitancy. Medical science can be applied in cases like using past flu strains to develop better vaccines in the future. Additionally, data science can be used in cases like determining which groups of people to focus on when trying to increase vaccination rates. By using the methods in this paper, like increasing confidence in the system, vaccine rates can increase and thus save many lives that would otherwise be lost. Lastly, it can help many people increase their knowledge of vaccines so they can detect any misinformation they encounter in their lives. I will be pursuing the Innovation Practicum as a junior and aim to learn more about machine learning, artificial intelligence, and computer science in general.

Sophomore Innovation Interest Statements

Effects of Batteries on our Environment - Solutions, using Chemistry and Electronic Engineering
Finn Dyer

The use of batteries in applications, such as portable electronics and electric vehicles, has increased in recent years. The problem here comes with the creation of these batteries, and the end of their usable life. With an increase in production of batteries comes an increase in waste; when these batteries are disposed of, hazardous chemicals from the battery can leak out into the environment from a landfill. There are multiple strategies that can be used to limit this environmental impact; reducing their use, using rechargeable batteries instead of disposable ones, and recycling batteries when possible rather than sending them to a landfill. One of the solutions to this problem in the field of chemistry could be in the research of metal-air batteries that use oxygen as a cathode. These could end up having higher energy density, longer life, and be safer compared to traditional lithium-ion batteries. All of these factors can contribute to a lower environmental impact. Another study, in the field of electronic engineering, used a neural network to regulate battery state of charge, and make a safer, more reliable charging/discharging system for a battery pack. This can lead to longer battery life, and therefore, reduce battery waste. The employment of these strategies could cause less damage to the environment which will positively impact the lives of many people, plants, and animals. For my Innovation Practicum work, I would like to research in the field of computer science, with a focus on neural networks and Artificial Intelligence.

Understanding and Treating Opioids' Effect on the Brain
Gavin Tantleff

Through a profit-driven and dangerous marketing of oxycodone as safe with low risk for addiction, an epidemic of opioid addiction has manifested in the United States. This epidemic has caused the mortality rate of opioid drug overdoses to rise exponentially since 1980. Through neuroscience, the effects of opioids and their addictive properties can be studied. For example, one study found that when injected with opioids, a noticeable increase in dopamine levels was not shown in participants. This suggests that opioids do not use dopamine to cause addiction, but instead use other reward sites. Another scientific field of interest is pharmaceutical science. Through pharmaceutical science, drugs can be developed that can save lives by resuscitating overdose patients. A study found that some opioids require longer, continuous injections of naloxone in order to counteract the effects of an overdose. Future research into the opioid epidemic is incredibly necessary. It should further investigate how opioids affect the brain, and how addiction is caused, fought, and prevented. Further research should also investigate the effectiveness of naloxone and other opioid antagonists, in order to increase the accessibility of these life saving drugs. I am going to pursue the Ingenuity Innovation Practicum and will be mentored by Dr. James Foulds from the Department of Information Systems at UMBC. I am interested in the field of machine learning, specifically in regards to fairness and bias.

Sophomore Innovation Interest Statements

Reducing Concentrations of Industrial Heavy Metals
Henry Fancher

My research is focused on finding a cost efficient and effective solution to reduce and remove industry-produced toxic/heavy metals. Hazardous materials containing various metals or chemicals create contaminated soil, disruptions in habitats, and large bodies of pollution. Engineering and botany play a major role in the ability to reduce heavy metals. Engineers have been developing various solutions to remove heavy metals from water, including membrane filtration and nanotechnology. One study focused on a removal process through ultrafiltration which was essentially a thin filter that allowed liquid to pass through it picking up any excess waste materials depending on pore size. This study proved to be effective, showing high removal rates of 93% for cadmium and 86% for chromium. Another study I found involved the use of cheap agricultural byproducts to remove heavy metals from water sources. Other researchers conducted tests that revealed rice husks effectively removed heavy metals with a concentration range of 20–60 mg/l through absorption. Heavy metals in water from industries can have a negative impact on ecosystems and humans through its ability to travel through groundwater, surface water, and seepage. Water sources that are popular for animals, plants, and humans are plagued with these pollutants and are in close proximity to industries. The community will have to find ways to ensure its cleanliness to not put anything or anyone at risk. I have chosen to pursue the Innovation practicum to learn more about statistics and the impact this field has on our society.

Mental Health Issues in the Midst of a Pandemic
Sara Freeman

First presented in 2020, COVID-19 has majorly impacted our population. COVID-19 has not only caused a great increase in our death toll, but also increased mental health problems throughout the world. COVID-19 has caused immense amounts of stress, anxiety, and depression. These mental health issues are mainly due to stress induced by the pandemic and isolation. Neuroscience helps us understand the impact mental health has on the brain. For instance, people with mental health problems have reduced brain tissue and hippocampal activity, meaning that ultimately mental health issues have a direct impact on a person's memory and learning capabilities. Machine learning can help predict mental health issues, they can be predicted by having the ability to foresee the amount of cases and a person’s chance of survival. Machine learning will factor in certain traits of a person in order to predict their chances of survival from COVID-19. Knowing a close friend or family member’s chances of survival can potentially help to ease a person’s stress making it less likely for major mental health issues to develop. From this research, we can learn how to handle mental health issues now and in the future, by taking critical steps that have come to our attention throughout this pandemic. For the Ingenuity Innovation Practicum, I will be working with Dr. Swaroop Vedula from Malone Center for Engineering in Healthcare at Johns Hopkins University.

Sophomore Innovation Interest Statements

How a Lack of Greenspace Impacts Childhood Development
Abby Hartman

Human adaptation to the increase in global urbanization is a field of interest for many researchers. To better understand this topic, insights from neuroscience and biology can be applied. For example, in my research, I am looking at how urbanization impacts children's development neurologically and microbially to which the effects disproportionately impact poor children living in urban areas. Some articles I read suggested that exposure to soil, and the healthy microbes within, increases biodiversity in the human gut microbiota, which prevents allergies and autoimmune diseases. I also researched how children are particularly susceptible to these benefits since their immune systems are not fully developed. Likewise, a neurological experiment found that children living in residential areas with the highest concentration of calculated greenspace had the lowest odds of performing "not normally" on tests for hyperactivity and psychomotor speed. This research opens up possibilities for effective solutions to these problems. Using calculated vegetation indexes, experts in the field can determine the amount of vegetation needed in urban areas to prevent microbial and neurological complications from arising in children. Soon after, the green space can be integrated into these communities as a result of this advocacy. My future research with Ingenuity's Innovation Practicum will pertain to how mental health disorders impact children's development.

Trapped: How Prisoners may be Secluded in both Body and Mind
Oluyinka Ojolayo

Millions of people go to jail, in some places more than others. While prison was made to prevent crime and keep offenders held accountable, the living conditions of these said prisons can make their inmates behavior even worse. This project focuses on the impact of prison practices and the impact of the overall prison environment on its inmates. Whether it be programs, social structures, or punishments, they all have an impact on their prisoners. The data for this project is recorded through a wide array of studies that all have the common fields, statistical and Neurological analysis. Neuroscience is important to find out how these practices impact their brain, and statistics to know any trends. It's important to identify prisons' impacts because they are some of the defining factors that influence who they are when released. While the factors can be hard to spot, it is essential to know that or that programs which work on rehabilitation show any success. It is hoped that more awareness on the subject will improve the mental and emotional security of distressed inmates and help prevent issues in which their impact negatively overlaps. My continued work will be with Dr. Eltoweissy, The Associate Dean in Cybersecurity at Morgan State University, to learn more about cybersecurity.

Sophomore Innovation Interest Statements

How GMOs and GM Crops Benefit Humanity
Liam Reilly

Genetically modified organisms (GMOs) and genetically modified crops (GM crops) are now more important than ever with the increasing population of humanity and the increased damage that climate change is producing. GMOs and GM crops can curb these problems with their benefits of being resistant to climate change and increase production than non-GM crops. These benefits also stabilize and/or increase the GMO accepting country's economy. This is shown with the decreasing amount of credit loans going out to farmers in Brazil after the adoption of GMO soy was introduced, along with financial areas and contracts also going down. The adoption of GM crops in countries decreases the effects of climate change brought on to agriculture. Drought resistant maize in Africa is a prime example of GM crops fending against climate change effects on agriculture. There are many people worried about the effects of GMOs with the thought that they are unnatural and should not be eaten. However, they are perfectly natural with them paralleling the natural process of evolution. Evolution of crops, in the most simplest of terms, is the random changing of genes that help the plant to adapt to its environment. However, with GMOs this process is not random with desired genes being chosen to be put in the plant or animal. These chosen genes are usually inserted into the organism through a virus or small metal beads. This means if Humanity wants to feed itself it needs to adopt GMOs. I am pursuing the Ingenuity Innovation Practicum and I am interested in machine learning and AI with it predicting events in the future.

How political parties affect vaccination rates
Noah Simcox

Vaccinations are becoming increasingly important in light of COVID-19. Unfortunately, politics have played a pivotal role in vaccination rates among the large parts of the U.S. Although many immunological studies have found that vaccines were not only safe but stayed effective for long periods of time, vaccination rates have been lower based on a person's political affiliation. How can scientific evidence be ignored in favor of political propaganda? Statistical analysis studies of an individual's educational background based on political affiliations may help to give us a deeper understanding of why this is. This research helps us to explore the reasons people are either getting vaccinated or not. Also, by having this information vaccination rates may be increased by knowing how to effectively counteract the negative messaging. I am pursuing the innovation practicum where I would like to work on data analysis or coding.

Sophomore Innovation Interest Statements

Predicting, Intervening, and Healing from PTSD
Cosima Billotte Bermudez

Post-Traumatic Stress Disorder is a damaging mental illness with symptoms such as severe anxiety, flashbacks, and remaining in a constant state of fear. My research is focused on identifying the pre-existing contributors, the development, and the treatment of PTSD using biochemistry and neuroscience. One way we can predict increased susceptibility to PTSD is by examining the biochemistry of genetics. One study showed that the absence of the 10R allele (responsible for increased expression of the dopamine transporter gene) in one's genetic makeup is correlated with a susceptibility to PTSD. Understanding the alleles responsible for the expression of the dopamine transporter gene will help us manage PTSD development. Another study used the neuroscience of gyrification (the process of creating the folds in the brain that allow greater cognitive function) in the cortex of human brains. This study included two groups: one with PTSD and one control. Each participant had an MRI scan, which showed the level or degree of gyrification. After controlling for demographic and IQ factors, it was found that there were positive correlations between gyrification and PTSD severity. This tells us that abnormal gyrification can be a sign of PTSD. Researching the risk factors of PTSD will prevent future cases, and researching treatment methods will assist in the healing of already developed cases. Improving mental health is crucial to our society, and reducing PTSD is a beginning step. I am pursuing the Innovation Practicum and will be mentored by Dr. Rajiv McCoy from the Department of Biology at Johns Hopkins University.

Improving the Reliability and Effectiveness of Autonomous Vehicles by Using Computational Techniques
Vahe Zaprosyan

At least 90% of motor vehicle crashes are caused by some sort of human error. Features of autonomous vehicle (AV) systems can play a role in preventing a majority of these crashes. However, more work is needed to improve the effectiveness of AV systems. Firstly, artificial intelligence (AI) is one discipline that allows autonomous vehicles to be more reliable in their decision-making processes. For instance, a study used skeletal representations of pedestrians to develop an algorithm to determine the intentions of such pedestrians by tracking their limb positions. A challenge with implementing AI into AV systems would regard issues with tracking sensors, since they are essential for gathering information about vehicles' surroundings. The discipline of mechanical engineering is able to solve this problem, as optimization frameworks, such as VESPA, have been used to calculate the most optimal sensor placements and orientations to achieve the goals of AV systems. A study on VESPA showed that it resulted in a 12.5% decrease in the object occlusion rate, meaning that the sensors were now able to detect more objects. Thus, these results show that optimization frameworks can be created to produce more effective sensor configurations. Generally, improving features of autonomous vehicle systems can allow countless accidents to be prevented, and thus will save many lives. I am pursuing the Ingenuity Innovation Practicum and research cybersecurity, working will Dr. Eltoweissy, The Associate Dean in Cybersecurity at Morgan State University.

Class of 2022: College Acceptances

** denotes the college /university the senior will be attending*

Ron Marc Adante,
Baltimore City Community College

Oluwadamilola Akinola
University of Maryland-Baltimore County
Morgan State University*

Angelique Allen
Brandeis University
University of Maryland, College Park
Pennsylvania State University
University of San Francisco
St. Mary's College of Maryland
Temple University
Wellesley College*

Virtue Bama
University of Delaware
University of Maryland, Eastern Shore
University of North Carolina, Wilmington
Waynesburg University*

Jordan Bass
Bowie State University
University of Maryland, College Park*
North Carolina A&T State University
Spellman College

Elyjah Bassford
Eastern University
Goucher College
Johns Hopkins University – Baltimore Scholar*
Loyola University Maryland
University of Maryland-Baltimore County
St. Mary's College of Maryland

Tsairus Beasley
Carnegie Mellon University*
University of Maryland-Baltimore County

Me'Shiah Bell
Rensselaer Polytechnic Institute*
Suffolk University

Hayden Benhart
Haverford College*
University of Maryland-Baltimore County

Lilia Berninzoni
University of Maryland-Baltimore County
Morgan State University
Temple University
University of Vermont*

Shubhan Bhat
University of Maryland-Baltimore County*
Morgan State University
Salisbury University
Towson University

Dylan Buise
Harford Community College*

Amare Campbell
Pennsylvania State University
Purdue University*

Keith Ceruti
Ohio Wesleyan University*

Taylor Chase-Bynum
Johns Hopkins University*
University of Maryland, College Park

Ethen Cheng
University of Maryland-Baltimore County
University of Maryland, College Park

Class of 2022 College Acceptances

Precious Conteh

Eastern University

Hampton University

Jackson State University

Lincoln University

University of Maryland-Baltimore County

University of Maryland, College Park*

Lilian Couch

Champlain College

Eckerd College

Elon University*

James Madison University

Saint Joseph's University

Towson University

Nicolas Del Pino

Case Western University

Princeton University*

St. Mary's College of Maryland

Nicole Dia

Carnegie Mellon University

Goucher College

Johns Hopkins University*

Kayla Douglas

Loyola University of Maryland

McDaniel College*

Morgan State University

Towson University

Chesapeake Dowdy

George Washington University*

University of Maryland-Baltimore County

University of Maryland, College Park

Alexis Duke

Bowie State University

Clark Atlanta University

Florida Agriculture and Mechanical University

Hampton University

Howard University

Morgan State University

North Carolina A&T State University*

Samuel Elkins

University of Colorado Boulder

Harriett Engelke

University of California – Santa Barbara

University of Maryland-College Park

University of Michigan – Ann Arbor*

University of Pittsburgh

Miles Fancher

University of Hawaii at Manoa

University of Illinois at Urbana-Champaign

University of Maryland-Baltimore County

University of Maryland, College Park

University of Pittsburgh*

Stony Brook University

University of Vermont

Justin Frederick

University of Maryland, College Park

Saint Mary's College of Maryland*

Towson University

Caitlyn Gantert

Boston University

College of Charleston

University of Delaware

University of Maryland, College Park

Rochester Institute of Technology*

Class of 2022 College Acceptances

Taylor Gardner
Georgia State University*
University of Maryland, College Park
McDaniel College
Pennsylvania State University
Virginia Commonwealth University

Niles Garrison
Louisiana State University
Morehouse College*

Zen Gordon
Chatham University
Goucher College
Loyola University of Maryland
University of Maryland, Baltimore County
University of Maryland, College Park (Honors Program)
Presbyterian College
Stevenson University
Towson University

Avipsa Hamal
Loyola University of Maryland
University of Maryland, College Park*
Temple University

Andrew Haye
Hampton University
Loyola University of Maryland*
University of Maryland-Baltimore County
University of Maryland, College Park
Morgan State University
Saint Mary's College of Maryland

Ashantae Hayward
American University
College of the Atlantic
Case Western Reserve University
George Washington University
Louisiana State University
Muhlenberg University
Old Dominion University
University of Pittsburgh
University of Richmond
Tulane University*

Johns Hopkins
Reed College
Rensselaer Polytechnic Institute
University of Rochester*

Gael Islas
Rochester Institute of Technology*
Towson University

Adrian Jackson
Morgan State University*

Walker Johnson
Lafayette College*

Taylor Jones
Clark Atlanta
Hampton University
Howard University
University of Maryland-College Park
Morgan State University
Mount St. Mary's University
New York University
North Carolina A&T State University
North Carolina Central University
Spelman College*
Towson University
Xavier University of Louisiana

Diego Jovel
University of Maryland-Baltimore County*
Seton Hall University

Kayla Le
Johns Hopkins University (Baltimore Scholar) *

Madeline Martak
Community College of Baltimore County
Frostburg State University
University of Maryland-College Park*
Towson University

Class of 2022 College Acceptances

Deondre Martin
Fordham University
Loyola University Maryland
University of Maryland-College Park*
North Carolina A&T State University
Pennsylvania State University
University of Pittsburgh
Wake Forest University

Liyah McCormick
Clark Atlanta University*
Hampton University
Louisiana State University
University of Maryland Eastern Shore
North Carolina A&T State University
Tuskegee University
Virginia State University
Xavier University of Louisiana

Jordan Mister
North Carolina A&T State University*

Daudi Mwangi
Loyola University of Maryland
University of Maryland-Baltimore County*

Marie Naka
Dickinson College
Elizabethtown College
Indiana University-Bloomington
Millersville University of Pennsylvania
Trinity College*

Meredith Nishiura
College of the Atlantic
Eckerd College
University of Maine
St. Mary's College of Maryland*
University of Vermont

Aruoriwo Odedoyin
Auburn University
Hampton University
Howard University
Louisiana State University
University of Maryland Eastern Shore
University of Maryland–Baltimore County
University of Maryland-College Park*
McDaniel College
Morgan State University
Temple University
Tuskegee University
Xaiver University of Louisiana
University of Delaware

Oluwayemisi Ojolayo
Clark Atlanta University
University of Delaware
Frostburg State University
Goucher College
Hampton University
Hood College
Howard University
Johns Hopkins University (Baltimore Scholar)*
Spelman College
St. John's College
Temple University
Towson University
University of Maryland-Baltimore County
University of Maryland-College Park
University of Maryland-Eastern Shore

Simon Olsen
Georgia Institute of Technology
University of Maryland-College Park
(Banneker-Key Scholar)*
New York University

Class of 2022 College Acceptances

Ketandu Onyike

George Washington University
University of Maryland-Baltimore County
University of Maryland-College Park*
University of Massachusetts-Amherst
Purdue University
Rensselaer Polytechnic Institute
Virginia Polytechnic Institute and State University
Worcester Polytechnic Institute

Jose Orellana-Guzman

Colorado State University-Fort Collins
University of Maryland-Baltimore County
(Meyerhoff Scholar)*
Stevenson University
Temple University

Jack Overton

Roanoke College
St. Mary's College of Maryland*
Ursinus College

Whittney Patterson

Hampton University
University of Maryland Eastern Shore
McDaniel College*
Morgan State University
North Carolina Central University
Salisbury University
Towson University
Winston-Salem State University
Xavier University of Louisiana

Elisabeth Paulk

University of Maryland-College Park
Sarah Lawrence College
Smith College*
St. Mary's College of Maryland
College of William and Mary

Muswe Pembamoto

University of Maryland-Baltimore County
Morgan State University
Mount St. Mary's University
Stevenson University
Towson University*
Washington College

Riauna Poole

Bowie State University (Ozzie Newsom Scholar)*
Duquesne University
East Carolina University
University of Maryland-Eastern Shore
University of Maryland-College Park
Morgan State University
North Carolina A&T State University
Pennsylvania State University
Temple University
Towson University

Nyla Powell

Johns Hopkins University (Baltimore Scholar)*
University of Maryland-Baltimore County
University of Maryland-College Park
Morgan State University
Spelman College

Mika Prada-Enzman

The University of Alabama
University of Colorado Boulder
Hofstra University
University of Maryland-Baltimore County
University of Maryland-College Park*
Ohio State University – College of Engineering
Rochester Institute of Technology
Ohio State University
Towson University

Class of 2022 College Acceptances

Ilijah Roberts
Baltimore City Community College
Baylor University
Belmont University
Bowie State University
Clark Atlanta University
Delaware State University*
Frostburg State University
Lincoln University
Louisiana State University
University of Maryland-College Park
University of Maryland-Eastern Shore

Jose Rugerio-Mejia
Community College of Baltimore County*

Logan Sampath
Georgia Institute of Technology
University of Maryland-Baltimore County
University of Maryland-College Park
(Banneker-Key Scholar)*
University of Pittsburgh
Rochester Institute of Technology
University of Wisconsin - Madison

Christina Sarbanes
Barnard College*
Reed College
Spelman College
St. Mary's College of Maryland

Mia Schildbach
Bucknell University
University of Maryland-College Park
Mount Holyoke College
Purdue University-Main Campus
University of Rochester
Rutgers University-New Brunswick
Smith College*

Jonah Schwartz
Columbia University*

Jacquelyn Sin
University of Maryland-College Park*
University of Pittsburgh
Towson University

Kendall Smith
Clark-Atlanta University
Delaware State University
Frostburg State University
Hampton University
University of Maryland-Baltimore County*
University of Maryland-Eastern Shore

Henry Stone
University of Colorado, Boulder
University of Maryland-College Park*
Temple University

Jazmyn Thorpe
Georgia State University
North Carolina A&T State University*
Virginia Commonwealth University

John Elek Yuhas
University of Rochester*

Aram Zaprosyan
University of Maryland-Baltimore County
University of Maryland-College Park*
New Jersey Institute of Technology
Pennsylvania State University
Towson University
University of Virginia

Research Awards and Honors

Congratulations to Ingenuity seniors and juniors for their dedication to research despite unprecedented challenges in research and education due to the COVID pandemic.

Seniors: Hayden Benhart, Keith Ceruti, Precious Conteh, Zen Gordon, Andrew Haye, Ashantae Hayward, Johns Hopkins III, Meredith Nishiura, Nyla Powell, Logan Sampath, Mia Schildbach, Jonah Schwartz, Jala Wallace, John Yuhas.

Juniors: Odin Adams, Julio (Gabe) Alumbro, John Angelloz-Dugan, Malcolm Connor, Mara Coughlin, Samuel Rufus Doroja, Edith (Ouisie) Engelke, William Grant, Murad Habtu, Chloe Harrison, Jalen Henson, Sai Gayathri Kurup, Yuki Lin, Holland Low, R'Reeyah Mabry-Francis, Frebruk Mikre, Sarah Patterson, Kaif Rehman, Eden Rhodes, Jordany Gonzalez Roman, Anna Rousos, Nicholas Santiago, Skylar Strickler, Mia Urban, Hero Williams, Harrison Yezzi, Iris Zheng.

Junior Science and Humanities Symposium (JSHS)

Meredith Nishiura earned 3rd place for the Maryland JSHS with her project **"**Effects of an Urban Estuary on Blue Crabs and Blue Crab Diet." She went to New Mexico to participate in the national JSHS competition.

Morgan State University Science-Mathematics-Engineering Fair

Earth and Environmental Science

1st Place, **Meredith Nishiura**, "Effects of Urban Estuaries on Blue Crabs and Blue Crab Diet"

3rd Place, **Mia Schildbach**, "Studying the Ediacaran Period through the examination of a fossil from the Deep Spring Formation of Nevada"

Biological Science

3rd Place, **Jala Wallace**, "Investigating Remdesivir Post Exposure Prophylaxis Activity"

4th Place, **Zen Gordon**, "Developing Early Detection Methods for Ovarian Cancer"

Honorable Mention: **Jonah Schwartz**, "Fabrication of Circular Channels in Hydrogel to Model in vivo Fluid Flow"

Honorable Mention: **Nyla Powell**, "The Usage of SUMO Proteases (SENPS) as a Potential Cancer Biomarker"

Mathematics and Computer Science

2nd Place, **Keith Ceruti II**, "PACMan: Mitigating Bias in Proposal Reviews"

3rd Place, **Johns Hopkins**, "Using Machine Learning to Predict Ground Reaction Forces"

Society of Women Engineers – Outstanding Engineer — Meredith Nishiura, "Effects of Urban Estuaries on Blue Crabs and Blue Crab Diet"

American Metrological Society American Meteorological Society — Mia Schildbach, "Studying the Ediacaran Period through the examination of a fossil from the Deep Spring Formation of Nevada"

Student Publications

Effect of Strain-Specific Biofilm Properties on the Retention of Colloids in Saturated Porous Media under Conditions of Stormwater Biofiltration. Yue Zhang, **Claire C. Wayner**, Shanshan Wu, et.al. *Environmental Science and Technology, 2021, 55, 4, 2585–2596.*

Fe XVII 2p–3s Line Ratio Diagnostic of Shock Formation Radius in O Stars. **Gabriel J. Grell**, Maurice A. Leutenegger, and Chintan Shah. *The American Astronomical Society. The Astrophysical Journal, 2021, Volume 917, Number 2.*

Math Education in Ingenuity

Since 2001, approximately 40 Ingenuity graduates attended leading colleges and universities and became professional mathematicians. Ingenuity cultivates students' love of math through preparation for the following experiences.

A New Math Sequence: In 2022-23 school year, one Ingenuity class at Poly will follow an accelerated math sequence: Algebra 2 and Elementary Functions in grade 9, AP Calculus AB and Trigonometry/Probability and Statistics in grade 10, AP Calculus BC in grade 11 and Linear Algebra and Differential Equations in grade 12. Ingenuity's new Linear Algebra and Differential Equations course offers a range of advanced topics of elementary mathematics and some topics which are usually taught in college.

Johns Hopkins University Future Scholars Program

The Future Scholars Program, led by the Mathematics Department at Johns Hopkins University, allows high school students to take college math classes for credit. Nominated students are given a challenging qualifying exam to be considered for this highly selective program. Students who qualify are able to register for one Johns Hopkins University math course per semester without tuition costs and enjoy the advice and mentorship of Hopkins Mathematics faculty.

Each year up to 10 students are chosen to be Future Scholars across the state of Maryland, and one to four of those students are from The Ingenuity Project. Our students have enrolled in classes such as, Linear Algebra, Advanced Linear Algebra, Differential Equations, Multivariable Calculus, Number Theory, or Abstract Algebra. Some of these students later earned PhDs in Mathematics or Physics.

Lynne Cure, **Antonio Romerio** and **Josh Tagle** have been accepted into the Program for the 2022-23 school year.

Math Club and Regional Competitions

The Ingenuity Math Club at Poly was established by Dr. Goldenberg in 2001 and he has moderated the club every year since. Annually about 20 students participate, studying advanced math topics and solving Math Olympiad-like problems. Dr. Goldenberg prepares club members for math competitions such as, the Maryland Math League, the University of Maryland High School Mathematics Competition, and the American Mathematics Competitions AMC-10 and AMC-12.

Since 2002, our students have won multiple prizes and become school and city winners. On a regular basis our AMC participants are invited to participate in the American Invitational Math Examination, which is the next level of this national math competition.

Baltimore Scholars Program

Between 2007 and 2022, more than **100** Ingenuity students have been accepted into the Baltimore Scholars Program at the Johns Hopkins University. The students receive cohort programming, scholarships that help cover tuition, room and board, and fees.

800 SAT and SAT Subject Test Scores

Between 2001 and 2022, Ingenuity students received **126** perfect 800 SAT and SAT subject test scores. For this time period, the average Math SAT score was 693, and the average SAT Math 2 score was 699.

The first Ingenuity student to receive an 800 on Math SAT was Robert Watkins in 2001. Robert went to Yale and graduated from Columbia Law School in patent law and technology law. Currently he is a senior legal counsel at Apple.

Class of 2022

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

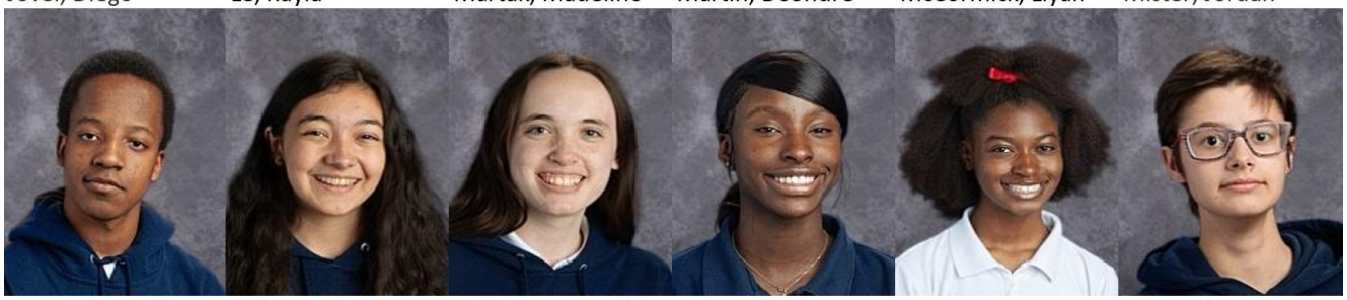
Campbell, Amare | Ceruti, Keith | Chase-Bynum, Taylor | Cheng, Ethen | Conteh, Precious | Couch, Lillian

Del Pino, Nicolas | Dia, Nicole | Douglas, Kayla | Dowdy, Chesapeake | Duke, Alexis | Elkins, Samuel

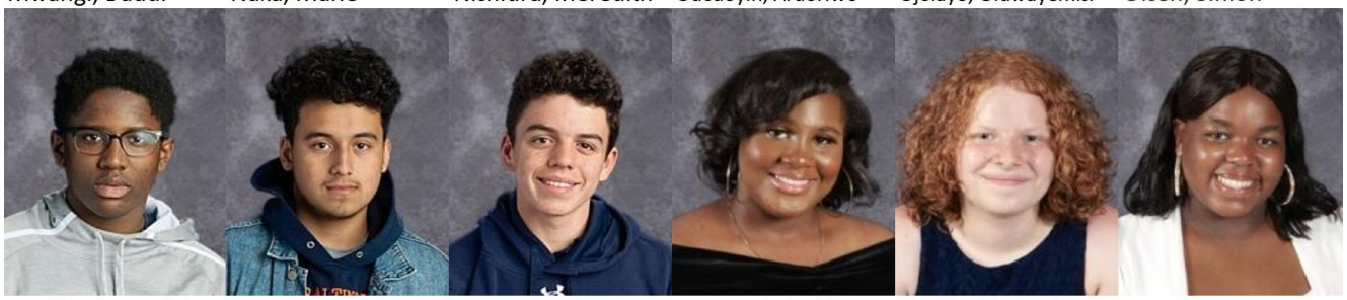
Engelke, Harriett | Fancher, Miles K | Frederick, Justin | Gantert, Caitlyn | Gardner, Taylor | Garrison, Niles

Gordon, Zen | Green-Dorsey, Khrystian | Griffin, Nasia | Hamal, Avipsa | Harris, Jaden | Haye, Andrew

Jovel, Diego | Le, Kayla | Martak, Madeline | Martin, Deondre | McCormick, Liyah | Mister, Jordan



Mwangi, Daudi | Naka, Marie | Nishiura, Meredith | Odedoyin, Aruoriwo | Ojolayo, Oluwayemisi | Olsen, Simon



Onyike, Ketandu | Orellana-Guzman, Jose | Overton, John | Patterson, Whittney | Paulk, Elisabeth | Pembamoto, Muswe

Poole, Riauna | Powell, Nyla | Prada-Enzmann, Mika | Roberts, Ilijah | Rugerio-Mejia , Jose | Sampath, Logan

Sarbanes, Christina | Schildbach, Mia | Schwartz, Jonah | Sin, Jacquelyn | Smith, Kendall | Stone, Henry

Thorpe, Jazmyn | Torregoza, Jose Enric | Wallace, Jala | Wies, Louie | Yuhas, John | Zaprosyan, Aram

Class of 2023

Adams, Odin | Alumbro, Julio | Alvarado jr, Jose | Anderson, David | Angelloz-Dugan, John | Blackman, Evelyn

Breitmeyer, Hannah | Budhai, Rohan | Calderon, Marcos | Celnik, Lucas | Chinn, Malakai | Clark, Temar

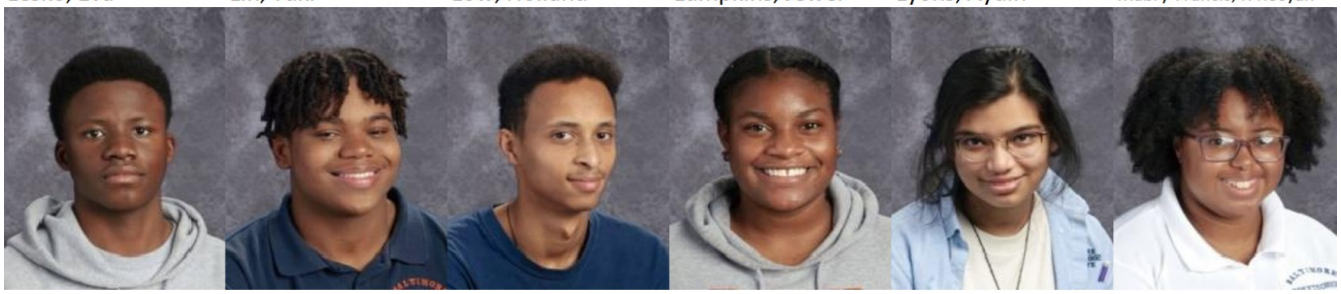
Connor, Malcolm | Coughlin, Mara | Cure, Lynne | Diaz-Franco, Alexandra | Doroja, Samuel | Engelke, Edith

Estep, Kenneth | Franco, Brandon | Frock, Matthew | Grant, William | Habtu, Murad | Harris, Keyierra

Harrison, Chloe | Heaggans, Jaelin | Henson, Jalen | Hines, Lashaya | Hollis, Amaya | Holt, Wyatt

Horwitz, Anabel | Jacobson, Nicholas | Jimenez, Royce | Jones, Azariah | Kurup, Sai Gayathri | Lee, Alexander

Lesko, Eva | Lin, Yuki | Low, Holland | Lumpkins, Jewel | Lyons, Aydin | Mabry-Francis, R'Reeyah



McDaniel, Ethan | Meredith, Donald | Mikre, Frebruk | Mintz, Tijah | Mukherjee, Ayesha | Norman, Carmen

Offor, Michael | O'Maonaigh, Elliot | Paranilam, Jaeci | Patterson, Sarah | Rahim, Muhammad | Rehman, Kaif

Reichelt, Julian | Rhodes, Eden | Rollins, Anthony | Roman Gonzalez, Jordany | Rousos, Anna | Rubenight, Evyenia

Rumber, Kaliah | Sandoval, Olivia | Santiago, Nicholas | Sheppard, Tenard | Smith, Dayvonte' | Smith-Burden, Alexander

Solefack, Cerena | Strickler, Skylar | Sun, Kevin | Thomas, Tres'jour | Urban, Mia | Waller, Daphney

Watts, Mazario | Williams, Hero | Woody, Denmark | Wynn, Sorensen | Yezzi, Harrison | Yoseph, Stephan

Zheng, Iris

Class of 2024

Aime, Nimah | Ankobia, Kimathi | Atkins, Felisha | Beauvois Ransome, Evan | Bender, Sophia | Berninzoni, Matteo

Billotte Bermudez, Cosima | Blanchard, Yasmine | Boehringer, Leo | Boykin, Jasmine | Castelan, Cristofer | Chen, Maria

Clark, Levi | Coffey, Camille | Davis, Markell | Dickens, Alexander | Drummond, Madison | Dungee, Jackson

Dyer, Finneus | Eblaghie, Ethan | England, Jhamari | Erdas, Antonio | Fancher, Henry | Felder, Kendall

Freeman, Sara | Gapeev, Vladimir | Gedansky, Dean | Geller, Ira | Glaros, Reid | Griffin, Ellen

Grigsby, Kai | Hall, Lavender | Hartman, Abigail | Hastings, Cenae' | Hayrapetyan, Aram | Holly, Kayla

Hong, Zoe | Isbell, Brandon | Langkammerer, Hudson | Lapp, Louis | Lawson, Caleb | Leith, Christian

Lemon, Katelyn | Lin, Alvin | Lindsey, Ryan | McCalla, J'Zanae | McKenna, Eliza | Mese-Jones, Kei

Mese-Jones, Miya | Molina, Maya | Odeh, Anthony | Ojolayo, Oluyinka | Overton, Amelia | Pevsner, Ava

Polansky, Ruby | Providence, Stephen | Reichelt, Cecelia | Reilly, Liam | Roach, Toni | Romerio, Antonio

Schenkel, Penelope | Schmelyun, William | Schmitz, Margaret | Schreier, Reuben | Schulman, Susan (Lu | Shrestha, Krrish

Simcox, Noah | Singleton, Ta'Quory | Smith, Jaiden | Stanton, Kayla | Stanton, Kierra | Stine, Anson

Tagle, Josh Daniel | Tantleff, Gavin | To, Henry | Torres-Hernandez, Erick | Valery, Bowen | Vey, Charles

Wheeler-Oluwagben | Wilcox, Cerenity | Wilkerson, Melia | Williams, Mahalia | Zaprosyan, Vahe

Class of 2025

Abrams, Remy | Adams, Lillian | Adedoyin, Nadiat | Ahmed, Anis | Ajayi, Christopher | Allen, William

Amador, Jaidy | Benhart, Sawyer | Berger, Tamarra | Boldon, Samuel | Boldon, Matthew | Bridgeford, Sanaai

Brown, Lia | Brunelle, Mina | Bunch, Da'Mario | Carter, Aidan | Castelan, Josue | Chacko, Sophia

Crowder, Myron | Dikeman-Dorsey, Nikola | Dugan, Pierre | Edwards, Jayauna | Faison, Brandon | Fitzgerald, Canaan

Franco-Martinez, Lec | Gauvin, Tuck | Gedansky, Madeleine | Gill, Salloni | Gittens, Francis | Goldenberg, Alyssa

Goodwin, Maya | Green, Jazmine | Griffin, Leia | Harris, Tyler | Hijam, Bryan | Hill, Ayanna

Hughes, Kassia | Hunt, Maxwell | Jenkins, Kaila | Kelly, Emily | Lam, McKenna | Lipson, Bella

Lyons, Tracy | Malone, William | Massey, Joseph | McCray, Kennedy | McIntyre, Hafid | Micah-Jones, Leo

Mokaddem, Aydin | Muher, Brian | Okoronkwo, Chidubem | Okororie, Bennett | Okororie, Joseph | Onque, Mekhi

Paulk, Margaret | Pender, Wryen | Perry, Marquell | Pitt, Victoria | Richardson, Sukarno | Riddick, Jade

Rodriguez, Yamely | Roller, Sebastian | Ross, Sawyer | Savage, Aiyana | Seldon, Kaitlyn | Serpick, Jack

Shah-Nelson, Rishi | Singh, Malik | Smothers, Brazil | Solefack Momo, Helen | Sproge, Mia | Streat, Caleb

Talley, Aidan | Valcarcel, Samuel | Vigues, Pierre | Vizachero, Lorenzo | Washington, Gabriella | Yacobucci, Matthew

Zimmer, Kevin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future
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Acknowledgements

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

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

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Ingenuity Project Staff

Baltimore Polytechnic Institute Administration

Symposium Student Committees

Publicity: Jala Wallace (senior chair), Elek Yuhas, Jonah Schwartz, Eden Rhodes (junior chair), Hal Yezzi, Chloe Harrison, Gabe Alumbro, Ouisie Engelke, Odin Adams.

Event Night: Andrew Haye (senior chair), Mia Schildbach, Johns Hopkins, Ashantae Hayward, Precious Conteh, Jordany Roman Gonzalez (junior chair), Yuki Lin, John Dugan, Holland Low, Mia Urban, Murad Habtu, Mara Coughlin.

Appreciation: Meredith Nishiura (senior chair), Zen Gordon, Hero Williams (junior chair), Sai Gayathri Kurup, R'Reeyah Mabry-Francis, Sarah Patterson, Skylar Strickler, Anna Rousos, Samuel Rufus Doroja.

Program: Hayden Benhart (senior chair), Keith Ceruti, Nyla Powell, Frebruk Mikre (junior chair), Malcolm Connor, William Grant, Jalen Henson, Kaif Rehman, Nicholas Santiago, Iris Zheng.