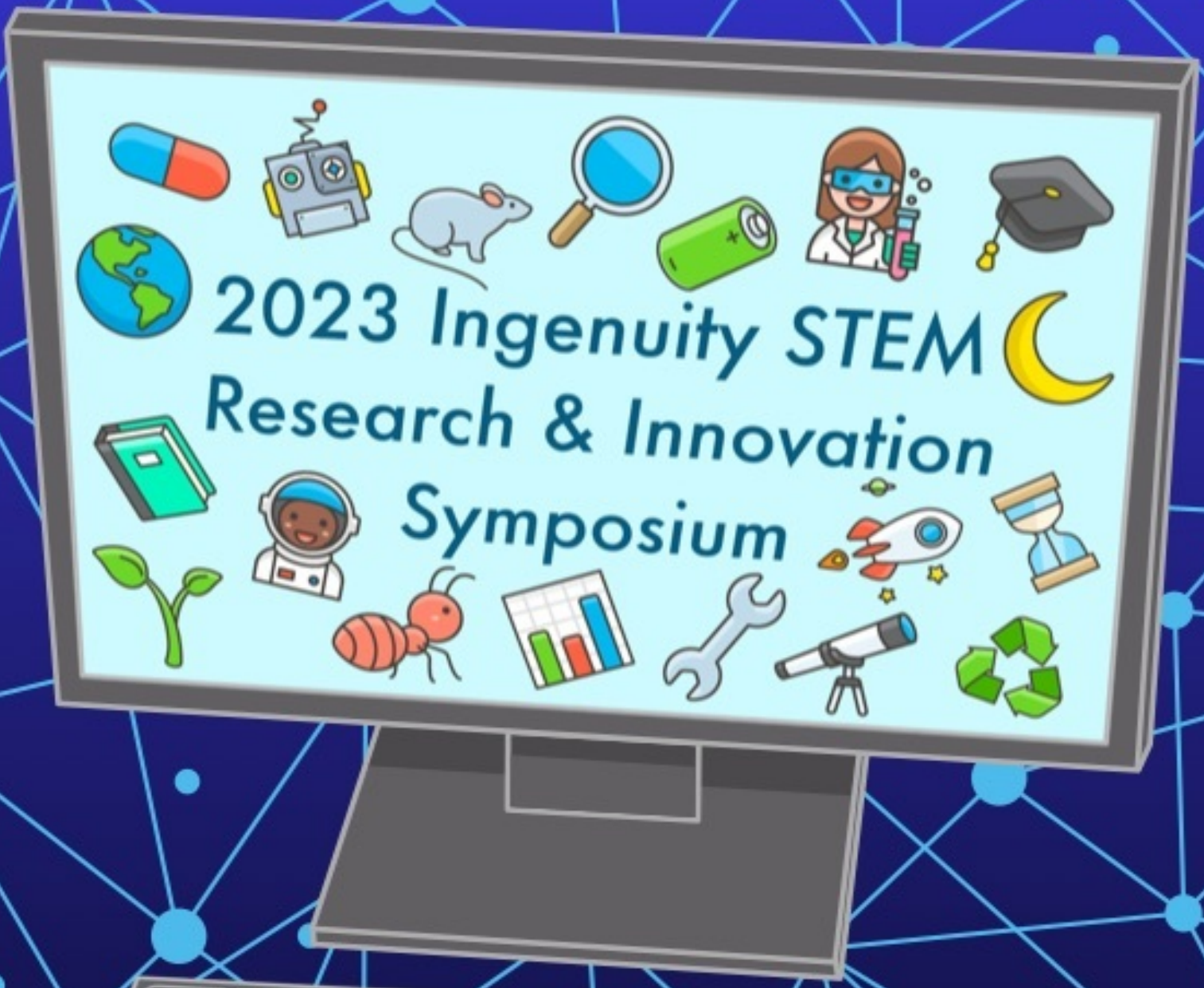

Morgan State University | May 17th, 2023

A Note from the Director

Dear Guests,

Thank you for being a part of our 21st Annual Symposium! This event is an important hallmark of Ingenuity's STEM education at Poly, giving students the opportunity to present the results of their original research. The Class of 2024 Research & Innovation students worked hard to prepare for our first off-site Symposium at Morgan State University!

Ingenuity has been nurturing and advancing the talents of Baltimore City students in STEM thanks to the generosity and commitment of our community of skilled teachers, dedicated research mentors, caring families and supportive donors. We can celebrate these positive outcomes together:

- **68% of Ingenuity 6th graders,** who entered the program last year after a virtual 5th grade, made growth in mathematics, as measured by the iReady assessment and many exceeded typical growth.
- **More than 90 percent of students** participate in at least two AP classes in math or science class each year, compared to 42% participation in AP statewide.
- For 4 years in a row, **close to 80%** of our students have achieved a 4.2 Grade Point Average or higher by graduation.
- **100%** of our first generation students finishing our program for the past 5 years were offered full or nearly full rides to competitive colleges.
- **More than 80%** of the class of 2022 enrolled in competitive or highly competitive colleges.

Ingenuity humbly thanks and congratulates Mrs. Williams on her retirement! The impressive outcomes for all the students Poly could not be possible without the support, guidance, and partnership of Mrs. Jacqueline Williams, class of 1981, who has been the fearless leader of Poly for ten years and dedicated a lifetime to the students and community of Poly.

This spring, we also celebrate the retirement of long time Ingenuity teacher, David Nelson. Mr. Nelson began his relationship with Ingenuity as a middle school science teacher, then coordinated Ingenuity's hallmark research program for 11 years. Through the mentoring of Dr. Goldenberg, he shifted gears to become Ingenuity's Geometry and Algebra 2 teacher for the past 7 years, fulfilling his interest to apply his skills as an engineer to the math classroom. Mr. Nelson has impacted the STEM education of hundreds of students and we are very grateful for his dedication to Ingenuity's mission. Please join me in thanking Mr. Nelson for his outstanding contributions.

Thank you for joining us tonight! Together, we're shaping Baltimore City's STEM future.

Sincerely,

Lisette

Lisette S. Morris
Executive Director

Developing Leaders Since 1883

Congratulations to the Ingenuity Poly class of 2023 for your research and discoveries!

This ad proudly sponsored by Pat Tracy (Poly '72) & Robin Tracy (Western '73)

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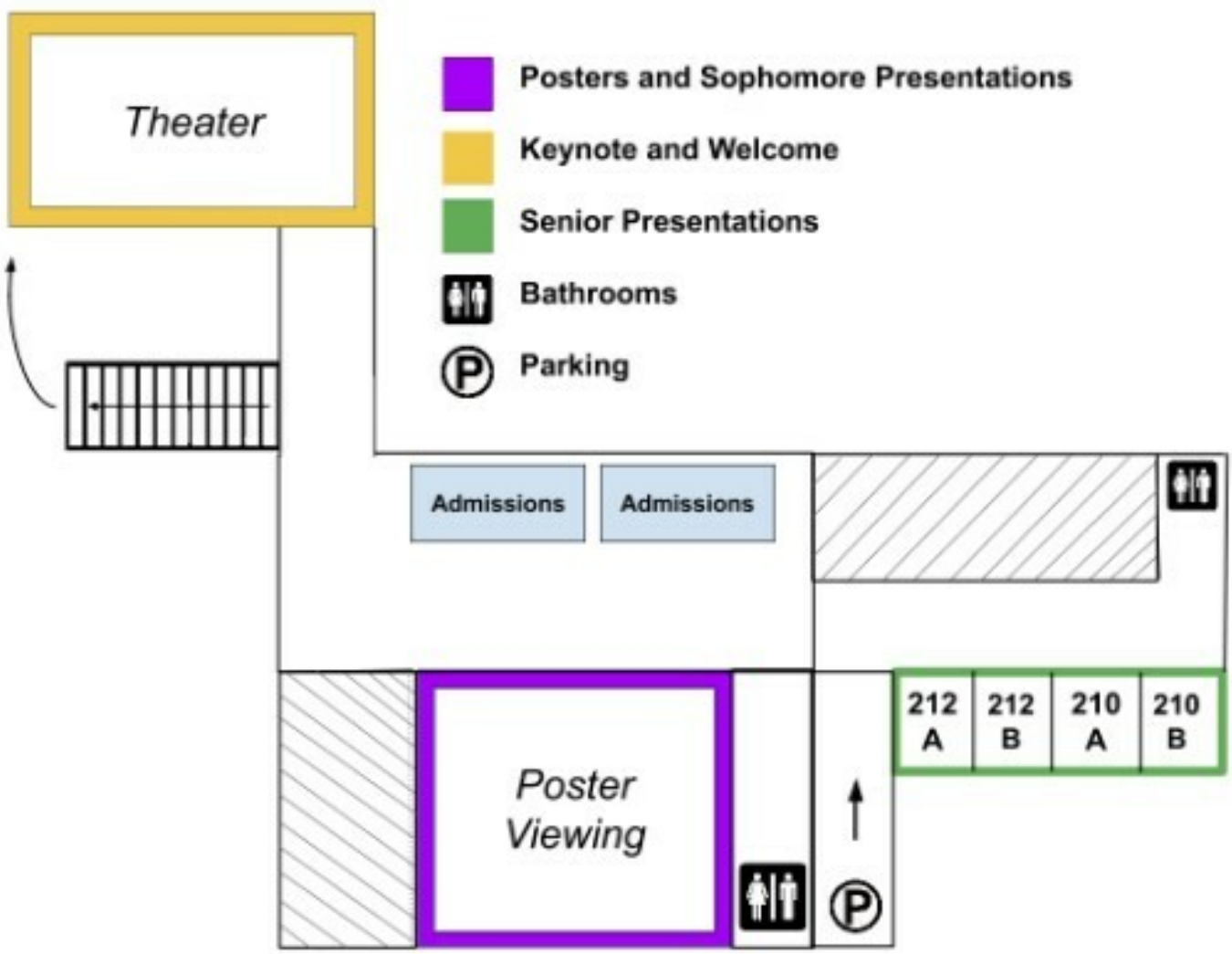
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Presentations

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Room 210 A	Sai Gayathri Kurup	Investigating The Effect of Trichostatin A on Acetylation of RelA for the Prevention of Preterm Birth
Room 210 B	Kaif Rehman	Analysis of Small Shelly Fossils and Ocean Chemistry of the Early Cambrian Period in the Poleta Formation
Room 212 A	Antonio Romerio	Fibonacci Numbers and the Golden Ratio
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7:55 - 8:10 PM		
Room 210 A	William Grant	Investigating Relationships Between AGN Output and the ISM
Room 210 B	Holland Low	The Impacts of Modulating Reaction Time on Active Sensing in Weakly Electric Fish
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Room 212 B	John Dugan	Comparison in Growth and Filtration Rate of Fouling Communities Grown on Different Substrates

About the Keynote

Brooke Story

Worldwide President,

Integrated Diagnostic Solutions

BD

Brooke Story joined BD, one of the largest global medical technology companies in the world, in 2021 as Worldwide President, Integrated Diagnostic Solutions (IDS), and is responsible for driving global strategic, operational, commercial performance and customer experience across the BD IDS portfolio.

IDS is recognized as an industry leader in delivering transformative, end-to-end solutions from specimen collection and transport to diagnostic testing in laboratories and non-traditional care settings, ensuring our customers' success in achieving improved performance and positively impacting clinical outcomes.

Prior to joining BD, Brooke served as President, Pelvic Health and Gastric Therapies at Medtronic. She held a variety of leadership roles at Medtronic over her 15-year tenure with the company.

Following her professional and personal passions, Brooke serves on the board of directors for LivaNova a worldwide leader in advanced circulatory support, cardiopulmonary and neuromodulation solutions company, as well as the board of Everyman Theatre, which provides transformative experiences through professional theatre that are welcoming, relevant, and affordable to everyone in the Baltimore/DC area.

Brooke was named one of Savoy magazine's Most Influential Black Executives in Corporate America 2022 in recognition of her executive and business leadership as an innovative trailblazer leading efforts to foster growth for high-performing companies throughout and beyond the US market. She is also an active member of The Executive Leadership Council, an independent non-profit that opens channels of opportunity for the development of Black executives to positively impact business and communities.

Brooke earned a bachelor's degree in Industrial Engineering from the University of Tennessee and an MBA from the University of Michigan, Ross School of Business.

The Ingenuity Project
Program Overview

The Ingenuity Project

A seven-year advanced STEM program providing curriculum, enrichment, and support to nearly 900 students in four middle schools and nearly 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.

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 to support Poly, keeping the school strong.

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 regional 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 seniors, this means entering the Regeneron Science Talent Search, the nation's oldest and most prestigious science and math competition for high school seniors. 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, a qualifier for the Regeneron International Science & 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

Master mathematician Dr. Mikhail Goldenberg initially constructed the Ingenuity Mathematics Program and is now under Ingenuity's lead mathematician, Elisa No. Ingenuity's math courses use a variety of textbooks and select 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. Most ninth-grade students begin with a year of Geometry: Proof and Problem Solving; tenth-grade students complete Algebra II and Elementary Functions and a semester each of Trigonometry and Probability/Statistics. Most eleventh-grade students complete Advanced Placement (AP) 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. Many students are now completing Ingenuity's Geometry course in eighth grade and preparing to take courses beyond Calculus BC senior year. 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 the Maryland Math League, the American Mathematics Competitions, the American Invitational Mathematics Examination, and the University of Maryland High School Mathematics Competition.

Abstracts

A Senior Research

FROM LEFT TO RIGHT

TOP *Odin Adams, Mara Coughlin, John Dugan, Nicholas Santiago, Iris Zheng, Kaif Rehman, Yuki Lin, William Grant*

BOTTOM *Holland Low, Mia Urban, Sarah Patterson, Gabe Alumbro, Sai Gayathri Kurup*

NOT PICTURED *R'Reeyah Mabry-Francis*

The senior's 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 nation pre-college competitions, including Regeneron Science Talent Search, Junior Science and Humanities Symposium (JSHS), and Morgan State University Science Mathematics Engineering Fair.

Correlation Between Precipitation and Human West Nile Virus Cases in California from 2009 to 2014

Odin Adams

Mentor: Dr. Meghan Davis
Department of Environmental Health and Engineering, Johns Hopkins University

Since 1999, West Nile virus (WNv) has had a significant impact on America's history, with 1% of cases developing neuroinvasive disease and a 9% mortality rate in neuroinvasive cases. 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 and clarify temperature's impact on WNv human cases in California from 2009 to 2014. In order to do this, data on monthly precipitation by county in California from the National Oceanic and Atmospheric Administration (NOAA) was linked to monthly human WNv cases by county from the California Department of Public Health. Correlation testing in R was used to explore potential associations between precipitation data, case counts, maximum temperature and minimum temperature. In addition, an analysis of average temperature, case counts, and the year are modeled along with average precipitation against case counts, per year. An analysis of this data might lead to a better understanding of how precipitation and temperature 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 established to mitigate WNv cases in humans.

Comparison of Composition Studies of Exoplanets

Gabe Alumbro

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

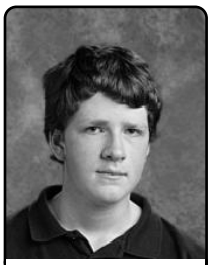
Human curiosity has prompted research on planets and other celestial bodies to understand the origins of the universe, search for extraterrestrial life, and investigate potential for off-world resource extraction. Exoplanets (planets outside of the solar system) are specifically studied to understand their interiors as well as gain more information about the evolution of Earth. Due to technological limitations, exoplanet data comes from space telescopes and our research is done on Earth. Because of a limiting factor such as space telescopes, exoplanet data is reused between research projects. This system has major flaws as the data could be outdated, which could affect future space missions from succeeding and alter current knowledge of space science. The goal of this research was to conduct a meta-analysis to measure the validity, reliability, and credibility of past studies, focusing on mass-radius graphs of exoplanets from previous studies. With a set criteria, nine datasets were obtained, concatenated with Python, and analyzed. The results showed that there was a dataset that was a degeneracy among the few. It was concluded that the dataset used data from a study from the 1970s, containing outdated ideas and research. This finding is important as future studies that use this data may interpret it incorrectly and affect their research. To further this study, it is suggested that to use a larger sample size to find more degeneracies between the results.

Phenolic Content's Correlation to Harmful Algal Blooms in The Field

Mara Coughlin

Mentor: Taylor Armstrong | **Supervisor:** Dr. Allen Pace
Place Labs, Institute of Marine and Environmental Technology

Harmful Algal Blooms are microscopic algae that release toxins into the environment or reach such high densities that cause oxygen depleted zones. These blooms are fueled from nutrient pollutants that humans put into water. The toxins released from these blooms have adverse effects on organisms in affected areas and cause damage not only to the ecosystem but also tourism industries and marine food sourcing. Phenolic compounds are antioxidants found in most plants; when found in water, this is due to the decomposition of aquatic plants or a result of runoff from nearby terrestrial sources. This project sought to find evidence of a negative correlation between Harmful Algal Bloom toxins and phenolic content in a natural setting. Samples 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 included domoic acid, goniodomin A, azaspiracid 1&2, brevetoxin, and dinophysis toxins: okadaic acid, dinophysin-1, and pectenotoxin-2, esterified dinophysis toxins. 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 results gathered did not provide enough evidence to determine a definitive conclusion regarding the correlation between phenolic content and algal toxins.



Comparison in Growth and Filtration Rate of Fouling Communities Grown on Different Substrates

John Dugan

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

Suspension feeders are organisms that feed on particles suspended in water, including microplastics, sediment, and, most importantly, algae. The focus of this study was to find ways to facilitate the growth of suspension feeder communities and to compare the amount of filtration performed by the various communities grown in an attempt to use suspension feeders as a way to combat pollution in urban estuaries and help restore marine ecosystem health. This experiment began with placing six different substrates in the water across three locations throughout the Baltimore Inner Harbor and measuring their weight as they accumulated sessile organisms over the summer. Ech community was then placed in a closed system and its ability to remove phytoplankton was evaluated. Organisms on all substrates demonstrated a reduction in chlorophyll-A concentration, except for the polystyrene rope, despite showing weight gain over the course of this study. These results indicate that suspension feeders may be a potential method for filtering excessive amounts of nutrients and algae out of urban marine environments, and suggests which surfaces are best for sessile growth. Further research is needed to assess the efficiency of suspension feeders on a large scale.

Investigating Relationships Between AGN Output and the ISM

William Grant

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

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 availability of data. Relationships between AGN and their host galaxies are being explored due to their possible connection between them which could give insight into galactic evolution. The growing supermassive black holes that power AGN are also of interest, as the reasonings behind their presence in some galaxies but not in others is not fully understood. Notably, AGN galaxies are observed to have a lower star formation rate than non-AGN hosts. This is due to the heating of the interstellar medium (ISM), whose source is still not confirmed. My research focuses on the energy output of the central AGN and the surrounding ISM, which fuels both star formation and black holes, as well as the possible correlation between them. Radio and x-ray data was prioritized; radio emissions are a result of synchrotron radiation due to the AGN, and x-ray emissions are most likely a result of “tidal shocks'' in the ISM. Various properties of the sources were compared to both those x-ray and radio luminosities. We found a high degree of correlation between the x-ray and radio luminosities and the S(3)/luminosity ratios, demonstrating a relationship between increased temperatures in the ISM and both AGN output and tidal shocks.. This could indicate that both are causes of the heating of the ISM, and thus decreased star formation in AGN galaxies.

Investigating The Effect of Trichostatin A on Acetylation of RelA for the Prevention of Preterm Birth

Sai Gayathri Kurup

Mentor: Dr. Laura Ensign | **Supervisor:** Marina Better
Center for Nanomedicine, 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 mediates inflammation, has been previously identified as a potential drug target for Trichostatin A (TSA). TSA is a histone deacetylase inhibitor (HDACi) that prevents the removal of acetyl groups on histones and other proteins. It has been shown to prevent PTB in murine models when combined with progesterone. However, the mechanisms behind how HDACi downregulates inflammatory proteins through interference with NF-κB signaling remain 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, PHM1-41 uterus cells were treated with TSA and a TSA-progesterone combination. A PCR test was performed on harvested cells to probe for mRNA expression levels of HDAC4, which HDACi is known to act against. The TSA treatment resulted in a lower fold gene expression of mHDAC4, suggesting that it effectively inhibited the deacetylation of RelA. This identifies the lysine acetylation site of RelA as a potential target site for TSA. These results shed light on TSA’s mechanism of inflammation reduction for potentially using HDACi as a therapeutic for PTB.

Understanding How Enoxolone Inhibits HNF4a and Reduces Lipoproteins

Yuki Lin

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

Lipoproteins transport lipids and cholesterol to different parts of the body that need it. However, the presence of too many lipoproteins can lead to blood clots and heart disease, causing 1 in 5 deaths in the U.S. One commonly used drug to reduce lipoproteins is statins, but reported adverse side effects include headache, dizziness and nausea. Newly developed drugs turn off the lipoprotein synthesis pathway, causing the body to function improperly. Therefore, new drugs for lipoprotein regulation are needed. The Farber lab conducted a drug screen to test 3000 compounds on zebrafish and found 48 hits that have some unknown mechanism in lowering lipoproteins. One of the hits, enoxolone, a compound from licorice root, is suspected to be an HNF4a inhibitor in other systems. HNF4a is a protein that regulates gene expressions of many components of lipoprotein synthesis. Thus, it was hypothesized that HNF4a is the molecular target of enoxolone in the modulation of lipoproteins. Enoxolone was found to dose-dependently reduce lipoproteins and not an inhibitor of our lipoprotein reporter system. BIM5078 and BI-6015 are known HNF4a inhibitors that were also found to reduce lipoproteins. I analyzed the effect of different HNF4a genotypes on lipoprotein production and if enoxolone would further reduce those levels. Results showed that genetic loss of HNF4a in zebrafish reduced lipoprotein levels; enoxolone will further reduce lipoprotein levels, indicating that enoxolone targets the HNF4a pathway to regulate lipoproteins. New therapeutics may decrease the risk of heart disease, leading to lower mortality rates.

The Impacts of Modulating Reaction Time on Active Sensing in Weakly Electric Fish

Holland Low

Mentor: Dr. Noah Cowan | **Supervisor:** Mr. Yu Wang
LIMBS Lab, Johns Hopkins University

Active sensing is the use of energy in exchange for the acquisition of information regarding one's surroundings (Zweifel and Hartmann, 2020). It allows humans and other animals to understand and adjust to potential obstacles by using their senses. Because both humans and electric fish have multisensory systems, they share similarities in active sensing behaviors. Scientists have studied how electric knifefish adapt to experimental stimuli through active sensing via similar approaches as used in experiments on humans; however, few studies have focused on how reaction time influences active sensing in animals. Reaction time can be thought of as the delay at which one physically responds to an event that sparks the response. The goal of this research is to determine the relationship between active sensing and reaction time by using weakly electric fish. It is hypothesized that the modified reaction times of the fish will require more movement during active sensing procedures to account for the delay. Using the concept of feedback control loops and LabVIEW, a filter was designed to adjust the reaction time of the fish and program the tube that served as a refuge for individual knifefish in this experiment. Through the study of its relation to active sensing, robots can be modeled to 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.

Analyzing the Ability of Artificial Textured Skin to Differentiate Surface Roughness

R'Reeyah Mabry-Francis

Mentor: Dr. Jeremy Brown | **Supervisor:** Dr. Neha Thomas, Alexandra Miller
Department of Mechanical Engineering, Johns Hopkins University

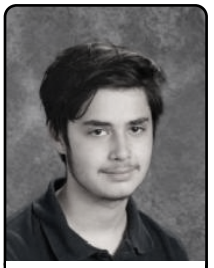
Upper-limb absence causes significant impediments in amputees' ability to execute everyday tasks. Able-bodied individuals are able to identify various textures and surfaces with touch, unlike amputees who have to rely on visual cues to determine the roughness or smoothness of a surface. To enable amputees with the ability to determine the surface texture through passive haptic feedback, a textured skin was developed for prosthesis fingers to enhance surface discrimination. Four prosthetic molds were created with different exterior textures/patterns ranging from minimally to maximally rough. An accelerometer was fixed to the textured skin to measure the vibrational profile of three experimental surfaces while the manufactured skin was moved across it by a linear actuator, programmed using Matlab/Simulink. Accelerometer readings and patterns generated by the textured skins across the various material surfaces were analyzed in Matlab to determine which textured skin could best identify the roughness of the surfaces. Results show that texture affects the ability of artificial prosthetic skin to discriminate surface roughness. Textured artificial skin would improve how users interact with their environment by allowing them to make distinctions between environmental surfaces. The capacity to make those distinctions would allow the user to change their approach in contacting surfaces, which can decrease the probability of surface abrasions on the prosthesis from rubbing against rough surfaces.

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, potentially leading 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 HIV/STIs and other 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 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 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. A statistically significant association was observed between ACEs and substance use. More specifically, ACEs were found to be associated with non-injection drug use. The impact of these results could help prevent the formation of negative coping mechanisms in adulthood due to the trauma experienced in childhood. Furthermore, these results could aid in the intervention of adults abusing substances, granting an understanding as to why they have resorted to these coping mechanisms.



Analysis of Small Shelly Fossils and Ocean Chemistry of the Early Cambrian Period in the Poleta Formation

Kaif Rehman

Mentor: Emmy Smith | **Supervisor:** Valerie 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. The primary objective of this research was to observe fossil evidence, as well as to conduct an in-depth analysis of carbon isotopes, in order to better understand the relationships between different Lower Cambrian deposits around the world. Carbonate rock samples were collected from the Poleta Formation in Esmeralda County, Nevada, a supposed Cambrian assemblage. These samples were run through a mass spectrometer in order to measure heavy carbon isotope values (C-13). An acetic acid solution was used to dissolve some of the samples and collect phosphatized fossils for study under a microscope. The C-13 of the formation was highly similar to those of other Cambrian reefs, and we found that the fossils represent small shelled organisms expected from the time period. One unique discovery was that of a fossilized helcionelloid mollusk, an organism never before found in the Poleta Formation. The biostratigraphic and chemostratigraphic (fossil specimen and C-13 data, respectively) data show that the Poleta Formation is from the Lower Cambrian. Our biostratigraphic and chemostratigraphic data will be available for future paleontologists to use and analyze for comparison against other deposits. 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.

Expression of Gal3 within Mouse and Human Models of Alzheimer's Disease

Nicholas Santiago

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

Alzheimer's Disease (AD) is characterized by the aggregation of proteins, amyloid-beta (Aβ) and tau, which results in the death of neurons (neurodegeneration). Microglia are cells found in the central nervous system (CNS) that function to engulf and consume foreign bacteria, particles, and pathogens. During AD's progression, microglia are thought to become detrimental to the brain, unable to keep up with the constant protein production. The result of this is chronic activation, in which microglia release cytotoxic molecules such as proinflammatory cytokines that promote neuroinflammation and cause neurodegeneration. Gal3, a focus of my research, is a protein expressed primarily by microglia, and is thought to be involved in the activation process. Human models Braak 0-6 and mouse models WT, APP, tau, and APP/tau brain tissues were previously stained for gal3, and were imaged to count expression levels. Upward trends of gal3 expression were found within human and mouse models, more specifically Braak 5-6 and APP/tau, which reflect the progression of AD. As these trends suggest that gal3 expression parallels AD progression, it can be assumed that gal3 is involved in microglial activation. It is possible that increased gal3 expression results in more microglia becoming chronically activated, exacerbating neuroinflammation and causing more neurodegeneration. From these results, it is possible that the inhibition or knockout (KO) of gal3 within microglia could result in slowing the progression of AD.

How Mudskippers Move in Amphibious Environments

Mia Urban

Mentor: Dr. Chen Li | **Supervisor:** Qiyuan Fu, Divya Ramesh
Terradynamics Lab, Department of Mechanical Engineering, Johns Hopkins University

In the past, animals have 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. My research studies how mudskippers move on mud to inform the building of robots that can traverse muddy terrain. When studying the terrestrial locomotion of mudskippers, much is already known about how these fish move on flat, solid ground, but not on more complex surfaces. On level ground, mudskippers use a "crutching" movement with their pectoral fins and a "skipping" movement when escaping predators. To study how these fish move on mud, 3 cameras were oriented around a container of mud. The cameras recorded different angles of how the fish moved on the mud, and these videos were tracked using DLTdv8 to find any patterns within the locomotion strategies of the fish. The tracked points were then input into Matlab code to find the depth of the fin as it went into the mud and the trajectory of the mudskipper. From my experiments, I found that the mudskippers consistently used the "crutching" movement when moving on mud. This research can be used to design the most effective robots that can traverse muddy, amphibious terrain.

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

CRISPR-Cas systems are utilized by bacteria 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 binds to 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 to hamper interference activity. Previous work 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 binding and interference activity. My work determines the binding and interference activity of the E. coli type I-E CRISPR-Cas system in the presence of off-target sites with insertion and deletion mutations. To answer this question, binding and interference in vitro assays were performed on supercoiled DNA substrates with one insertion or deletion introduced at different positions. Activity was verified using gel electrophoresis. Results show that binding activity occurs regardless of the mutation introduced, with an exception being a deletion of position +1/+2 (the first two nucleotides downstream of the PAM). Interference activity is tolerated when a deletion occurs outside of the seed region, with exceptions being positions +19/+20 and +11. Further biochemical and structural interrogation may clarify what features allowed these deletions to escape binding and/or interference, allowing researchers to design optimal surveillance complexes that reduce off-target effects and increase the specificity of CRISPR-Cas systems as a genome editing tool.

B Junior Research

FROM LEFT TO RIGHT

TOP *Maya Molina, Louis Lapp, Anson Stine, Bowen Valery, Leo Boehringer*

SECOND *Zari Wheeler-Oluwagbenga, Penelope Schenkel, Stephenie Providence, Margaret Schmitz, Amelia Overton, Lavender Hall*

THIRD *Kei-Leigh Mese-Jones, Camille Coffey, Ava Pevsner, Cecelia Reichelt, Charlie Vey*

FOURTH *Zoe Hong, Miya Mese-Jones, Ruby Polansky, Brandon Isbell*

BOTTOM *Maria Chen, Ellen Griffin*

The juniors are entering the final phase of their Research Practicum placements. Throughout the previous summer and 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 displays represent recent progress. Juniors submit their work to local competitions, including the Morgan State University Science-Mathematics-Engineers Fair and Maryland Junior Science and Humanities Symposium. The juniors, together with seniors, are also responsible for organizing the Symposium event.

Investigating Neutrophil Chemotaxis using Python Programming and Random Walks

Leo Boehringer

Mentor: Dr. Brian Camley
Department of Cell Biology, Johns Hopkins University

Neutrophil chemotaxis is a critical immune response mechanism by which neutrophils, a type of cell, move towards the site of infection in the body. In this study, we investigated the effects of biased and unbiased random walks on neutrophil chemotaxis using simulated neutrophil movement in a 2-dimensional environment. Random walks refer to mathematical models that simulate the path of a moving object. Biased random walks simulate directed movement, while unbiased random walks simulate random movement without direction. Our results showed that neutrophils with a higher degree of bias had a more efficient response to infection than those with a lower degree of bias, meaning that directed movement leads to a more effective immune response. We also observed that neutrophils with a lower degree of bias took longer to reach their target, indicating that random movement is less efficient. These findings suggest that the degree of bias in random walks affects the efficiency of neutrophil chemotaxis and could aid in the further investigation of chemotactic mechanisms and their implications.

Developing 6-Gingerol and EGCG Loaded Liposomes to Target Breast Cancer

Maria Chen

Mentor: Dr. Efie Kokkoli | **Supervisor:** Paul Kuhn
Department of Chemical and Biomolecular Engineering, Johns Hopkins University

One in eight women in the US alone are diagnosed with breast cancer, making breast cancer the most common types of cancer worldwide. 10-20% of all breast cancer cases are Triple-negative breast cancer (TNBC). Treatment of TNBC is difficult, as TNBC tests negative for all breast cancer receptors. Detection via these receptors permits the tailoring of therapies for patients. Thus, treatment requires strong forms of chemotherapy which have severe side effects resulting from non-targeted delivery. Liposomes are a type of nanoparticle made of both hydrophobic and hydrophilic components, allowing a wider variety of drugs to be encapsulated. Due to their ability to use specific cancer-targeting mechanisms, liposomes can deliver therapeutics directly to tumors, making them effective delivery agents. 6-gingerol, a main constituent of ginger, and EGCG, the main component of green tea, both have proven anticancer effects, but have not yet been studied in combination in a liposome. We will load a combination of 6-gingerol and EGCG into a single liposome and evaluate its effects on MDA-MB-231 TNBC cells through cell viability experiments and fluorescence uptake measurements. Results will help create and inform alternative treatments for cancer with fewer side effects due to improved targeting, allowing cancer patients to choose the right treatment plan for their needs.

Exploring Lipoprotein De-fish-encies as a Result of Genetic Mutations

Camille Coffey

Mentor: Dr. Steven Farber | **Supervisor:** Dr. Meredith Wilson
Department of Biology, Johns Hopkins University

One in three people are affected by metabolic disorders including obesity, high cholesterol, and high blood pressure. These increase risk of stroke, diabetes, and heart disease and are generally caused by issues with lipid storage, secretion, and lipoprotein production. Lipoproteins play a crucial role in lipid transport throughout the body in all vertebrates. The zebrafish is uniquely suitable for studying metabolic disorders because it's optically clear in its larval stages. My research revolves around mutations in the yolk, where the fish stores fats and proteins during embryonic and larval stages. Mutations were developed across the zebrafish genome using chemical mutagenesis to conduct a zebrafish mutant screen to investigate apolipoproteins. When zebrafish develop lipoprotein production disorders, the yolk becomes opaque, creating what is referred to as a "dark yolk". Additionally, my lab works with a transgenic fish line that allows for quantification and localization of ApoB particles, which are attached to lipoproteins linked with disorders like atherosclerosis. My research focuses on Mutants 22 and 17, two of over thirty dark yolk screen mutants. Complementation crossing against mia2/ctage5 mutants revealed Mutant 17 to have a similar mutation, research with other ctage5 mutants, crossed with the transgenic line, can help reveal the protein processes that influence lipoprotein production issues with the ctage5 protein. For Mutant 22, CRISPR/Cas9 editing is being used to find the target gene causing the dark yolk. Research in lipoprotein generation can help further knowledge of how metabolic diseases operate and ways to help those suffering from them.

Designing Therapeutic Antibodies Using Generative Artificial Intelligence

Madison Drummond

Mentor: Dr. Jeff Gray | **Supervisor:** Michael Chungyoun
Department of Biomedical Engineering, Johns Hopkins University

Therapeutic antibodies are antibodies that have been reengineered to perform an optimal task, such as to prevent diseases that span across major body systems. However, the process of creating a therapeutic antibody in a lab is timely and expensive. To handle this problem, we used computational methods to create a diffusion model based on the DALL-E model, which discovers patterns within a dataset and generates new data that share those patterns. Our model was trained to find the therapeutic version of any antibody that was inputted. This model is useful because it could aid in curing diseases that currently have no known cure, such as certain cancers. The program's versatility allows for a wide variety of applications, as it can be redesigned and tailored to specific needs.

The Zophobas Morio: A Possible Solution to the Plastic Crisis

Jackson Dungee

Mentor: Dr. Allen Pace | **Supervisor:** Luke Feeney
Place Laboratory, Institute of Marine and Environmental Technology

Plastic waste is ubiquitous and unavoidable, as it is found in every corner of the globe. Due to its low cost, durability, and insulating properties, combined with the fact that it is rarely recycled, polystyrene, a type of plastic, has become one of the most prevalent contributors to this issue. It accounts for around 30% of landfill space globally. The zophobas morio, commonly referred to as the "superworm", is the larva of the darkling beetle. Researchers have recently discovered that this insect is able to consume and digest polystyrene. It is widely believed that they have this ability due to a microbe in their gut biome that is able to digest plastic, presenting a possible remedy for polystyrene pollution. Although it may be impractical to use superworms to dispose of plastic on a large scale, it could be possible to isolate and analyze the specific microbe and synthesize a substance with similar characteristics. My study will look at the effects of the effect of polystyrene consumption on the growth and development of superworms and assess their ability to transform polystyrene into a biodegradable form.

Genomic Impacts of Exposing Hydra Viridissima to Zebularine

Ellen Griffin

Mentor: Dr. Alex Bortvin
Department of Embryology, Carnegie Institution for Science

The gene expression of all living organisms is based on how their DNA is expressed. A process that impacts DNA expression is methylation, a chemical process in which a methyl group, CH3, is attached to a biological component. Methylation of DNA impacts where DNA transcription is started, and therefore what proteins are created. Zebularine, C9H12N2O5, has shown to be a non-toxic methylation inhibitor. My project utilizes Hydra viridissima, small, simple, freshwater cnidarians, as a means in understanding how modifying an organism's ability to methylate its DNA impacts its genomic expression. In our lab's preliminary studies, zebularine has been shown to decrease the overall rate of cell proliferation observed through population, tentacles, and overall health of hydra. In my experiment, whole and bisected animals were exposed to zebularine through their media. Primarily, observations focused on tentacles, gonads, population count, reproduction rates, and proliferation and regeneration rates. Further experimentation would allow for research into the modifications on the genomic level regarding DNA. I am curious to see which segments of the DNA are inhibited from methylation, and how this process impacts the general protein production of hydra. Continuing the research would allow for expanded knowledge of the role of methylation and how its inhibition in other animals impacts their genome and expression.

Efficacy of Nonsteroidal Aromatase Inhibitors on the Sex Differentiation and Gonadal Development of Female Zebrafish

Levander Hall

Mentor: Dr. Ten-Tsao Wong, Mrs. Symone Barkley
Wong Lab, Institute of Marine and Environmental Technology

Monosex fish populations aid in decreasing early fish maturation, an issue faced by farmers when particular sexes mature earlier, giving fish less time to grow. To address this, researchers have begun exploring environmentally responsible and sustainable ways of creating neomales (genetic females sex-changed to males) that can be used to produce all-female populations. Aromatase inhibitors can help create neomales by preventing testosterone from converting to estradiol. However, using steroids or steroid aromatase inhibitors for creating neomales is largely restricted in the United States, but nonsteroidal aromatase inhibitors can answer this constraint. Casper transgenic zebrafish with green fluorescent ovaries or red fluorescent testes will be used to study the efficacy of three nonsteroidal aromatase inhibitors, Letrozole, Anastrozole, and Fadrozole. These compounds will be orally administered to females. Results are measured by observing gonadal development and changes of green fluorescent ovaries to red fluorescent testes, sex-specific gene expression, and through histology confirmation. The results of this experiment will aid in increasing the sustainability of aquaculture.

Split-Second Strategy: The Race Against Time To Make Decisions

Zoe Hong

Mentor: Dr. Christopher Fetsch
Department of Neuroscience, Johns Hopkins University

Despite how frequently we make decisions, little is known about the neural mechanisms behind them. To make a well-informed choice, people must identify a problem, gather evidence, evaluate their options, and apply a rule by breaking down the problem into smaller decisions. However, if there is not enough time to complete a specific task, decision-makers are unable to make a proper choice, as they cannot go through every step of the process. To examine the influence of time limits on decision quality, we will conduct an experiment through a game-like decision task. In this task, there will be three types of trials: one with a visible clock (indicating time limit/deadline), one with an invisible clock (hiding the time limit/deadline), and one with no clock/deadline. After making a binary decision in a set of trials, participants will report their confidence level. We predict that people may feel like their performance is getting worse regardless of accuracy, and it will do so to a greater degree when the deadline is invisible. This research may have implications for how people react when making real-world decisions under time pressure, allowing us to better understand the decision-making process.

Developing a Method to Investigate Color Preference and Circadian Rhythm in Drosophila

Brandon Isbell

Mentor: Dr. Andrew Gordus
Department of Biology, Johns Hopkins University

Color preference is a well-studied topic and primarily utilizes the fruit fly, drosophila, as a test subject. Previous research has shown that color preferences in drosophila are largely influenced by the intensity or brightness of a color. In addition to having preferred wavelengths, drosophila also prefer light within a certain range of intensities. A study by Lazupulo et al. (2019) suggested that the color preferences of drosophila also depend on time of day. However, it neglected to consider the influence of light intensity in color preference. To verify and expand upon the findings of this study, the Gordus lab redesigned the experiment with light intensity as a second independent variable. This research aims to deduce how color and light intensity preferences are influenced by the time of day. Using a programmable Arduino device, drosophila are provided with choices between light stimuli of varying colors and intensities. To assess color preference, the results of the experiment will be analyzed using a Python program. Due to its various human applications, such as in advertising, neuroscience, and pest control, the implications of this experiment are significant.

Guiding Responses to Climate Change: Integrating Fourier Transformation and Residual Learning for Arctic Sea Ice Forecasting

Louis Lapp

Mentor: Dr. Jianwu Wang | **Supervisor:** Sahara Ali
Department of Information Systems, University of Maryland Baltimore County

Arctic sea ice plays integral roles in polar and global environmental systems, notably ecosystems, communities, and economies. As sea ice diminishes due to climate change, it has become imperative to accurately predict sea ice extent. Using a dataset of Arctic oceanic and atmospheric variables spanning 1979 to 2021, a preliminary exploratory analysis was conducted to reveal temporal trends. Exploiting the trends observed, a sequential pipeline for predicting Arctic sea ice extent one month in advance was proposed. After a conditional detrender removed long-term linear trends, grid search iteratively tuned a composite Fourier Transform model for frequency threshold and number of iterations, thereby removing smooth oscillation. Using an expanding window approach, Gradient Boosting regressors were trained on baseline, detrended, and de-oscillated data. Cross-validated grid search determined optimal hyperparameter and lag combinations. A comparative analysis evaluated overall, monthly, and extremum performance with RMSE, NRMSE, and R2 metrics. The models trained on baseline, detrended, and de-oscillated data achieved successively superior performance. By outperforming current state-of-the-art and deep learning models, this study demonstrates the potential for employing Fourier transform-based pipelines in predicting oscillating time series data. Furthermore, this study may advise future adaptation, resilience, and mitigation efforts in response to Arctic sea ice decline.

Reconstructing Earth's Past: A Case Study in Potential Limitations With Using Traditional Methods

Kei Leigh Mese-Jones

Mentor: Dr. Emmy Smith | **Supervisor:** Iona Baillie
Department of Earth and Planetary Sciences, Johns Hopkins University

Sedimentary rocks are important tools in decoding Earth's history as minerals in sedimentary rocks can act as "time capsules," preserving ancient sedimentary chemistry from when they formed. Although several methods are used to evaluate the environmental conditions during a rock's formation, they may not provide an accurate representation of these conditions, as the chemical fingerprint can be changed by diagenesis, or post-formation, low temperature alterations. Therefore, it is important to determine whether the chemical signature of a rock records original sedimentary chemistry or the chemistry resulting from later processes that might have altered the rock. We do this through two case studies: (1) analyzing carbonates that have been partially dolomitized and (2) doing a study between outcrop and core shales to determine the effects of oxidative weathering. Preliminary results from the first case study shows isotopic offset between different carbonate mineralogies. The shales will be analyzed using iron speciation. Through these different analyses, we hope to provide insight into the reliability of geochemical methods of analysis in order to determine more accurate ways of assessing past environmental conditions.

Creating Aortic Repairs with Virtual Surgical Planning

Miya Mese-Jones

Mentor: Dr. Axel Krieger | **Supervisor:** Seda Aslan
Department of Mechanical Engineering, Johns Hopkins University

Coarctation of the aorta is a congenital heart disease that causes a narrowing in the aorta, the largest artery in the body. This disease prevents normal blood flow to the body, leading to increased blood pressure in the heart and increased risk of heart failure. To prevent this, we design grafts using a 3D imaging program with a 3D model of the patient's native aorta, which is obtained by MRI. These grafts replace the diseased area of the aorta with optimized geometry to increase blood flow. They are tested with virtual surgical planning to see the differences in blood flow between the repaired and native aortas. To validate the simulation, we 3D-print both the patient's native and fixed aortas. Using a flow loop, water is pumped through the aortas to mimic a heart pumping blood. The data are collected with flow and pressure sensors. We compare the data from the flow loop to the simulation to legitimize the simulation's data. When printed, the graft is made with an electrospinning technique, which acts as a scaffolding for blood cells. As blood flows through the graft, the patient's own cells replace it. As a result, it grows with the patient and does not have to be implemented again through surgery. These methods, especially virtual surgical planning, can be applied to many other surgical problems, which will help specialize and speed up treatment.

How Interactions Between Plants Impact their Resistance and Resilience during Drought

Maya Molina

Mentor: Dr. Meghan Avolio | **Supervisor:** Kelsey Coates
Department of Earth and Planetary Sciences, Johns Hopkins University

Heat waves in the United States are increasing, both in number and intensity. These heat waves may increase the severity and frequency of droughts, which could have impacts on ecosystem interactions between plant species. The interactions between plants can be described as competitive (inhibiting other plants' growth), or facilitative (positive or neutral). Prior to a drought, plants are predicted to be more competitive because of scarcity of resources. During drought, plants are more facilitative because there is more access to space and light. After a drought, the interactions are predicted to shift back towards competition. However, if the drought gets intense enough, all interactions are predicted to stop because of the extreme mortality. To explore this prediction, we will perform a greenhouse experiment using various combinations of two grassland plants, Andropogon gerardii and Solidago canadensis, exposing them to varying degrees of drought. By examining the effect of drought on the weight and soil water content in the different plant groups, we hope to explore how diversity, composition, and interactions between plants affect the resistance and resilience of plants under drought.

Development of a Novel Analytic Assay for the Detection of Disinfectant Byproducts in UV Filters and Swimming Pools

Amelia Overton

Mentor: Dr. Carsten Prasse | **Supervisor:** Daisy Grace
Department of Environmental Health and Engineering, Johns Hopkins University

Water, a necessary component for human life, can contain chemicals that are toxic to humans. When disinfectants react with organic matter in water, they produce disinfection by-products (DBPs). DBPs can be composed of a class of toxic chemicals known as electrophiles, which characteristically bind nucleophiles (for instance, DNA and proteins) and cause adverse health outcomes in humans due to this reactivity. Electrophiles cannot be easily analyzed and identified using traditional DBP detection methods, so methods have been developed to indirectly analyze electrophiles through their reaction with nucleophile microbeads. Specifically, we are investigating a class of electrophiles known as carbonyls. Using our optimized microbead assay, we can identify the carbonyl compounds contributing to the observed toxicity in swimming pool waters. Specifically, we will investigate the degradation of UV filters in sunscreens and observe if these DBPs are also found in sunscreen-containing pool waters. UV filters are known to break down into carbonyls when reacting with disinfectants which could cause health issues to people using them.

Decision Making: How the Path to a Consensus is Represented in the Brain

Ava Pevsner

Mentor: Dr. Veit Stuphorn
Department of Neuroscience, Johns Hopkins University

Decision making is a vital component of everyday life. Complex neural mechanisms underlie every decision we make, but there is not a universally agreed upon model defining how decision making is represented in the brain. A hypothesis outlined by previous research depicted a sequential model, suggesting that one aspect of a decision is processed before the next in a domino-like effect among populations of neurons. Another example is a parallel model, where multiple proposed courses of action compete simultaneously on a neural level in the brain. The aim of my research is to conduct an experiment that presents participants with a multifaceted decision: an objective aspect, where the participant attempts to select the correct answer to receive a reward; and a subjective aspect, where the decision is dependent on the subject's personal preferences. Using analysis tools in Matlab, data from this experiment can be used to support a sequential or parallel model of decision making, or represent a new paradigm altogether.

The Ants Go Marching One by One to Move Blocks

Ruby Polansky

Mentor: Dr. David Gracias | **Supervisor:** Aishwarya Pantula
Chemical and Biomolecular Engineering, Johns Hopkins University

Intricate fabrication and manipulation at micro size scales is one of the grand challenges of science, as it requires the use of complex techniques, expensive materials, and time. However, we can observe intricate and systematic fabrication all around us in nature, notably the collective behavior of ants to build large networks in soil to build their nests. To do this, ants communicate using pheromones, relying on their antennae to smell. Pheromones help distinguish what tasks ants are doing, as well as alert ants of how often they pass the same ants. Despite being excellent builders, ants are highly underutilized in the current fabrication schemes. Using Solidworks, I created a maze that will be 3D printed. The ants will be placed in one corner of the maze, with small boxes covered in oleic acid set in the opposite corner. I will run multiple trials using different concentrations of oleic acid to see which concentration produces the shortest response time from the ants. If we manage to pinpoint and control the collective behavior of ants we could potentially use them to build and manipulate structures at micro scales. This could potentially reduce operation and fabrication costs, and could give a wide range of function high resolution assemblies.

Developing Cryptochrome Optogenetic Mutants to Optimize Protein Recruitment in Cell Migration

Stephenie Providence

Mentor: Dr. Peter Devreotes | **Supervisor:** Dr. Dhiman Pal
Department of Cell Biology, Johns Hopkins University

Cell migration involves the movement of a cell from one place in your body to another. Previous research has used light to alter cell morphology, migration, and internal processes. The use of light tools and optogenetics is a crucial part of microscopy, as it is used to select specific proteins within a cell and collect visual data, allowing researchers to study and understand the chosen protein's function and the role it plays in the cell's migratory process. Cryptochrome 2 (CRY2), a protein from arabidopsis thaliana, activates in response to specific wavelengths of light and works in conjunction with optogenetics to give scientists greater control of experiments involving proteins. The activation of CRY2 recruits proteins from the cytosol to the cell membrane, and when in the absence of light, deactivates, allowing the protein to return back to the cytosol. Using CRY2, we aim to make cell imaging faster, convenient, and more efficient. In doing so, this research has the potential to find solutions to diseases such as immunodeficiency, cancer, and fetal deficiencies within a smaller time frame.

Analyzing Blue Crab Diets to Understand Biodiversity in the Inner Harbor

Cecelia Reichelt

Mentor: Dr. Eric Schott | **Supervisor:** Olivia Pares
Schott Laboratory, Institute of Marine and Environmental Technology

Baltimore's Inner Harbor used to be incredibly clean, clear, and biodiverse; it was full of oysters, crabs, and other organisms that benefitted Baltimore's economy. However, as Baltimore industrialized, both the environment and the harbors' health deteriorated, negatively impacting biodiversity. To remedy this, it is essential to study biodiversity, urban estuaries, and pathogen transmission amongst economically important species, specifically blue crabs. Blue crabs are a trademark in Baltimore, so they must be studied and protected. C. Sapidus Reovirus 1 (CsRV1), a pathogen commonly found in blue crabs was the focus of the research. To gain a better understanding of the virus, DNA barcoding was used to identify the presence or absence of CsRV1 in blue crabs, and this information was connected to the transmission and origin of the pathogen. If CsRV1 is present in the majority of the sample, then it could be assumed that the pathogen was very prevalent in blue crabs from that location. Results from this study can inform where the virus comes from and how it is transmitted. DNA metabarcoding was used to analyze and sequence blue crab stomach contents to gain an understanding of their diet. The results of the metabarcoding will inform us on the overall biodiversity of the Inner Harbor. If the blue crab diet is diverse, this implies multiple food sources were available. If not, we can conclude that they did not have a diverse prey community. The results of the study can give important information on how to improve the biodiversity in the Inner Harbor.

Prevalence and Disparities in Testing throughout the COVID-19 Pandemic

Penelope Schenkel

Mentor: Dr. Jacky Jennings| **Supervisor:** Alexandra Mueller
Department of Pediatrics, Johns Hopkins University

The COVID-19 pandemic became a global public health concern in 2020. Within months, multiple methods and locations for SARS-CoV-2 testing became available to combat the transmission of disease. In the context of the the distribution of free home-based tests provided by the United States government in January 2022, the objectives of this analysis were to (1) determine prevalence of SARS-CoV-2 testing and changes in testing prevalence over time; (2) investigate sociodemographic disparities in testing over time; (3) describe changes in reported ease of access to testing over time. This analysis used C-FORWARD, an ongoing randomized clinical trial that prospectively follows a cohort of Baltimore City households. Chi-squared, Fisher's Exact, and Student's t-tests were used for hypothesis testing. Results show testing prevalence increased over time. No significant associations were observed for race or education over time. Essential worker status, health insurance, and household annual income (2019) became associated with testing post-January 2022. Accessibility to testing and having tested were associated pre-January 2022 but not post-January 2022. These results reveal disparity within sociodemographic factors in Baltimore City, suggesting future research. Additionally, they prove useful in guiding future governmental action during pandemics.

Investigating Vacant Lots in Baltimore City to Convert Into Green Spaces

Margaret Schmitz

Mentor: Dr. Katalin Szlavecz | **Supervisor:** Ian Yesilonis
Department of Earth and Planetary Sciences, Johns Hopkins University

Baltimore has an increasing number of vacant lots as well as various vulnerable communities lacking greenspaces. This project will investigate if certain vacant lots in East Baltimore can potentially be converted into green spaces to benefit the surrounding communities. Composite and grid soil core samples were taken from lots deemed as potential green spaces. These cores were processed through sieving to determine pH, organic matter percentage, and heavy metal levels. This research hopes to aid in improving the lives of East Baltimore residents through increasing availability of green spaces. Additionally, this research informs soil research in other cities.

Ocular Dynamics of Walking C56BL/6 Mice

Anson Stine

Mentor: Dr. Kathleen Cullen | **Supervisor:** Brandie Morris Verdone
Department of Neurology, Johns Hopkins University

Understanding how vestibular input aids mice in stabilizing gaze is an important understanding within the field of neuroscience. The vestibular system allows the brain to perform self motion, posture and balance, and visual stability, though this study specifically focuses on visual stability. Within the realm of visual stability, there exists three main eye movements to redirect gaze; saccades, smooth pursuits, and vergence. These allow for the redirection of gaze between stationary objects, shifting gaze between moving objects, and movement of the eye in the opposite direction to keep images in the retina, respectively. This project aims to observe how mice use these eye-head stabilization strategies in fixed and free-moving behavior while walking. A combination of trials were used to evaluate both head-fixed and unrestrained head movement, while the eye and head position of mice were tracked through a video-oculography (VOG) setup. Mice used in the trials performed locomotion on a stationary treadmill while a headpost was implemented to keep their heads in place for select trials. Head-free mice were allowed to walk on the treadmill without mobility restrictions on the head. The results of this study examine the relationship between healthy C57BL/6 mice that have full vestibular-input and C57BL/6 mice that have vestibular-input, but lack vestibular information (hence the head-fixed position). Further research will additionally examine relationships between head-free and head-fixed movement through the observation of body movements, gait cycles, and more, using DeepLabCut, a markerless position tracker.

Colloidal Transport in Patterned Liquid Crystals

Bowen Valery

Mentor: Dr. Robert Leheny | **Supervisor:** Alvin Modin
Department of Physics and Astronomy, Johns Hopkins University

Unlike liquids, whose viscous properties are isotropic, meaning the properties of the fluid are independent of direction, the physical properties of liquid crystals are anisotropic, therefore direction-dependent. We study the gravity driven-transport of particles in a liquid crystal to investigate how they interact with a fluid with spatially patterned properties. Depending on the direction that particles travel through an anisotropic fluid, they will experience different apparent viscosities. Liquid crystals can be patterned to have a viscosity that varies in space by taking advantage of its anisotropic properties. In our research, we investigate liquid crystals with striped-shaped patterning. Particles can be driven through the patterned environment using gravity and their movements. As they interact with the varying viscosities that we imprint, observations can inform us how particles interact within anisotropic environments. This work has many applications in biology, such as through informing research about cargo transport within the cytoskeleton. Additionally, the spatial patterning can result in the self-assembly of particles, which may contribute to new innovations in chemistry, biology, and bottom-up technologies.

Exploring Organic Sulfur and Sedimentary Pyrite Variability in the Chesapeake Bay

Charles Vey

Mentor: Dr. Maya Gomes | **Supervisor:** Dr. Dana Brenner
Department of Earth and Planetary Sciences, Johns Hopkins University

As climate change continues to severely impact Earth's systems, studying the geological and chemical composition of oceans and waterways provides critical insight on the current and future state of our environment. This study focuses on the Chesapeake Bay, which is prone to the seasonal formation of low-oxygen zones and sulfide, primarily due to nutrient pollution. When sulfide forms in marine environments, it can react with organic matter which can drive down atmospheric CO2 levels, and it can also react with iron to form pyrite. These effects have been studied in stratified systems, but this study aims to learn more about how these processes are controlled in a seasonally anoxic environment. Sediment samples from six different sites in the Chesapeake Bay at varying water depths were analyzed for pyrite-sulfur concentration and isotopic composition, organic matter sulfur and carbon concentrations, and organic sulfur isotopic composition. This data will be used alongside data from an iron speciation experiment, which will analyze the reactivity and availability of iron in underlying sediments in the Chesapeake Bay. This work aims to use geological proxies to provide a new understanding of pyrite formation, along with the sulfur, oxygen, and carbon cycles.

Using Scale-Invariant Feature Transform to Measure Force in Tissues

Zari Wheeler-Oluwagbenga

Mentor: Dr. Daniel Reich | **Supervisor:** William Cortes
Department of Physics and Astronomy, Johns Hopkins University

Cells are the structure of all life, and understanding their underlying mechanics can lead to significant developments in biology and human sciences. Because learning about the physics of cell mechanics at molecular levels can be tedious, this project intends to automate part of the process by using Computer Vision algorithms, primarily Scale-Invariant Feature Transform (SIFT), to help visualize changes in tissues before and after manipulation. Because we have the same tissues from different time periods, the orientation of the images may not be the same, making it extremely difficult to track the movement of the cells within the tissues. This code will create a video of tissues over time by taking images within a data set and aligning them to be visually similar to view deformations. Focus on this algorithm is essential due to its positive implications for our lab and the applications it will have for the methodology of future research.

C Junior Innovation

FROM LEFT TO RIGHT

TOP *Levi Clark, Vahe Zaprosyan, Liam Reilly, Henry Fancher, Xander Dickens*

MIDDLE *Cosima Billotte Bermudez, Sara Freeman, Abigail Hartman, Yinka Ojalayo, Reid Glaros, Finn Dyer, Gavin Tantleff, Noah Simcox*

BOTTOM *Vladimir Gapeev, Madison Drummond*

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 learning 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 design to meet students' individual needs and ability levels.

Exploring the Foundations of Genetics and Diversity

Cosima Billotte Bermudez

Mentor: Dr. Rajiv McCoy | **Supervisor:** Dylan Taylor
Department of Biology, Johns Hopkins University

Genetics, in addition to the environment, largely control how people look and act and can impact their health. Genetic variation (i.e., mutations) affect gene expression (how much protein a gene produces), a major driver of trait differences between individuals. Genomic studies have provided crucial biological information, but are limited by lack of diverse population samples. If certain populations of people are ignored, we miss out on valuable information about potentially significant genetic differences. My research uses diverse datasets to answer questions about the kinds of genes that are differentially expressed between populations and understand the underlying sources of gene expression differences. I analyzed a large-scale diverse dataset to find expression-associated variants, gather several genes of interest, use prior evidence to identify their unique biological functions, and examine regulatory annotations of the associated variants in these genes of interest. Genomics contributes immensely to the progression of the medical world, for a specific example, the future treatment of personalized medicine. Populationally diverse individuals in GWAS datasets are incredibly essential in medicine to prevent health disparities and inequality. A treatment may be less or not at all effective for a population if the science behind it is biased. Through increasing the diversity of individuals used in genomic studies, we can improve the medical world.

Optimizing the Packaging System to Reduce Liquid Leakage in the Bionode

Levi Clark

Mentor: Dr. Pedro Irazoqui | **Supervisor:** Trevor Meyer
Department of Electrical Engineering, Johns Hopkins University

The Bionode is an implantable device that can record, stimulate, and transmit data wirelessly, used for processes such as the prediction and detection of epileptic seizures through deep learning. The clinical and academic applications of Bionodes make them an important device to optimize. The wireless design minimizes risk of infection as there is no need to remove the device to obtain recorded data or replace the battery. The hardware of the Bionode is kept in a soft packaging system made of silicone. When a Bionode is in an animal or human body, fluids can seep into the device and damage the hardware. My research aims to optimize the packaging system by maximizing the hermeticity and minimizing leakage. We used two solutions: phenolphthalein ($C_{20}H_{14}O_4$) and sodium hydroxide (NaOH) to mimic a device and body fluids. We tested a mixture of parylene coated and non-parylene coated tubes with a mix of sil-poxy, medical si, and kwik-sil silicone packaging layers to test the leakage. Our research aims to increase the time in which Bionodes can be implanted without leakage and without maintenance. As a result, we hope to decrease the risk of infection, avoid leaking, and increase device longevity.

Comparative Analysis of Machine Learning Models for Predicting Arctic Sea Ice Extent

Xander Dickens

Mentor: Dr. Md Osman Gani | **Supervisor:** Emam Hossain
Department of Information Systems, University of Maryland Baltimore County

Arctic sea ice extent (SIE) affects weather patterns throughout the world and is linked to climate change. Research has been done in order to create models that predict Arctic sea ice over time in order to hypothesize about the greater impacts of SIE changes. The challenges of predicting SIE have prompted researchers to develop machine learning models of varying complexity and scale. This research seeks to determine if ensemble models are better at predicting sea ice than simpler models, and also if only inputting variables that are causally linked to sea ice will increase the performance of a Long Short-Term Memory (LSTM) model. I compared three simple models to an Extreme Gradient Boosting (XGBoost) ensemble model and found that the simple models had an average RMSE of 8% while XGBoost had an average RMSE of 5%. Then, I used the PCMCI+ algorithm to determine which variables caused sea ice extent, and used this to create two deep-learning LSTM models, one with every input variable and one with only causal variables. This showed that including fewer, more important input variables increased model performance. This research indicates that complicated machine learning models are superior at predicting sea ice, and shows that using only causal variables can help improve model efficiency. Results can inform future researchers about the optimal types of models for SIE prediction, and contribute to current understanding of SIE's global impacts.

Automatic Computer Software Testing: Developing a Concolic Execution Tool

Finn Dyer

Mentor: Dr. Scott Smith
Department of Computer Science, Johns Hopkins University

Software development is at the root of all of the apps and websites that one uses on a daily basis. For a positive user experience, developers and designers must ensure software is bug-free and behaves as intended. Thus, testing software is essential. There are two ways of testing software: manually and automatically. Manual testing, or testing that is conducted by the programmer directly, is currently the most common method of testing programs, and is generally very inefficient; developing tests can take 50 - 80% of development cost and time. This study explores Automatic Software Testing, where, instead of manually testing, the process is automated with a computer, reducing the enormous cost and time consumption required for manual testing. For my research, I wrote a tool that can perform automatic testing on any program written in F-flat, a computer programming language. This tool explores every path the program could follow and gives the values of user input that lead to those paths. These input values can then be used to edit the program so every input gives the intended behavior. This tool is observed to be much faster than manual testing, as it can find the path to a specific point in the program almost immediately. The use of automatic testing can lead to more reliable systems and applications as final products, as well as providing these products to the end user faster and more economically.

Creating a Novel Microscopic Alignment Device

Henry Fancher

Mentor: Dr. Nina Markovic
Department of Physics, Goucher College

Customized nanoscale circuits are used in all modern electronic devices, from phones and computers to the controls of airplanes, buses, and cars. This project aims to construct a microscopic alignment device that would allow us to build customized nanoscale circuits in vacuums without lithography. Standard lithography uses a stencil mask that guides evaporated material onto a substrate, thus creating electrical leads on a sample. While the equipment is standard for lithography processes, the imaging stages leave impurities on the surface of samples that affect the quality and properties of the sample. The development of this device would be able to avoid the imaging and solvent processes of standard lithography while still achieving the correct placement of a stencil. The entire alignment mechanism that we are creating would consist of an array of capacitors and capacitive sensors on the substrate and the stencil. By altering the configuration of the capacitors, we will determine the precise placement of the stencil, within less than a micrometer, without the use of imaging or solvents. However, due to constraints in this project, the device is being modeled and tested with one capacitor on a larger scale.

Quantifying How Techniques for Screening Colonoscopy Vary Across Endoscopists

Sara Freeman

Mentor: Dr. Swaroop Vedula
Department of Computer Science, Johns Hopkins University

Colorectal cancer is a leading form of cancer among cancer deaths.. Despite the prevalence of colon cancer, there is not an established curriculum for its detection via colonoscopies, causing significant variations in techniques across endoscopists and resulting in a variety of patient outcomes. This study aims to find these variations and utilize the conclusions drawn to better the education of colonoscopies. We analyzed current techniques used by endoscopists by utilizing data collected by a sensor attached to the colonoscope, a tool that allows the endoscopist to review the colon during withdrawal. This sensor records the XYZ coordinates of the colonoscope and these points are then used to find the speed, path length, and changes in direction. Through the utilization of this data by a program, these techniques will be modeled to analyze any differences. We expect to find a large variation in these techniques and hope to find the beginnings of a standardized guide to performing a colonoscopy to minimize variation.

Using Machine Learning to Create a Sound Recognition Model

Vladimir Gapeev and Liam Reilly

Mentor: Dr. Sanjay Purushotham
Department of Information Systems, University of Maryland Baltimore County

The need for devices to recognize the outside environment through sound recognition is critical to daily life. Sound recognition is the process of differentiating sounds and having the ability to remove unnecessary sound from noisy environments. Sound recognition has become more significant in recent years due to its use in voice recognition, audio processing, and speaker recognition. This project aims to classify sound by using a backpropagation machine learning process with a softmax formula to train a model that is able to recognize ten common street sounds using the UrbanSound8K dataset, which contains sound clips of the ten sounds. The model uses segments of the clips to train the model and outputs the probability of what noise it is. The results of this model will be useful in further clarifying sound recordings for applications such as voice recognition, audio processing, and speaker recognition, by taking out unwanted sound and clarifying the data for the applications to process.

Stock Market Analysis and Prediction Through Study of Sentiment

Reid Glaros

Mentor: Mr. Nathan Henkle
T. Rowe Price

Sentiment Analysis, the evaluation of a text's emotional value, is an integral part in many programs across the web, but fails to meet widespread use by the public. By breaking down individual words, this form of analysis can determine the positivity and negativity of words. This can be found in many forms of programming, from Google searches to stock market prediction. This project focuses on the latter of these forms of programming, with the intent of creating a Sentiment Analysis program that can accurately predict stock market trends while maintaining the ability to function with non-financial texts. This was completed by tokenizing and cleaning data, followed by finding the numerical values of each word and finding the average value of the entire text. This value was then found for ten Apple stock-specific articles compared to stock market data from the week following the publication of these articles, to find if negatively worded articles corresponded with negative stock trends. By creating an all-inclusive program, the applicability of this program is endless and allows for the sentiment grading of stock related texts, no matter the professionality or style.

The Relationship Between Homelessness and Substance Use Amongst Youth

Abigail Hartman

Mentor: Dr. Margo Candelaria | **Supervisor:** Heather Whitty
Institute for Innovation and Implementation, University of Maryland Baltimore

Homelessness and substance use amongst youth is widespread in Baltimore. Youth Reach MD is a Maryland Project investigating this issue that pertains to youth experiencing independent homelessness (without a parent/guardian). In 2015, the Youth Reach program administered surveys across 24 Maryland jurisdictions. The Youth Reach mandate is to increase housing opportunities, invest in youth support services, work to mitigate the proportion of minorities suffering from homelessness as well as pregnant/parenting adolescents, and keep their pledge to implement effective strategies found in previous Youth Reach reports; for example, supportive therapeutic services for adolescent substance users. My research aims to investigate homelessness and substance use rates and how they differ by location. I am conducting chi-square tests of independence to observe any associations between youth who reported not living with their parent/guardian due to substance use or parental substance use and the location type they reported staying at the previous night. Afterwards, I will look at differences across the time points of 2017 and 2018. I hypothesize that there is a relationship and from there apply this research to the implementation of support services for those struggling with both of these issues.

Analyzing the Inaccurate Representation of Crime in Criminal Minds

Eliza McKenna

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

Humans are constantly absorbing information from the media around us in order to create new opinions on things we would otherwise not understand. Such a large access to media makes this so easy to do that we often don't think twice about it. However, there is a lot of inaccurate information in the world and with us being so reliant on the media this can have a large impact. This reliance is particularly relevant when it comes to crime as many people do not have first-hand experience with serial killers and violent homicide. To study this, we are conducting a content analysis on the television show Criminal Minds. We will watch and collect data on the show and then compare statistics on the killers, victims, and types of crimes to real life statistics to understand the extent to which crime is inaccurately portrayed. We have already seen harmful stereotypes perpetuated and the frequency of serious crime and the solve rate of these crimes being misrepresented. These results could aid in preventing the spread of harmful stereotypes, stress the need for more accurate media, and advise future studies on the effects of dramatized media on crime and other parts of society.

Comparing Qualifications for Maintaining Virtual Machine Identity

Yinka Ojolayo

Mentor: Dr. Mohamed Eltoweissy
Department of Computer Science, Morgan State University

Cloud computing is a new but widely used system which allows end users to utilize computer resources without being in close contact to servers. Without this, many companies would have to rely on investing in physical servers, which take up space and are often only able to be used locally. In order to manage the workload and constant use from their users, load balancing algorithms allocate requests using heuristic algorithms to balance resource utilization, thereby reducing resource wastage and preventing server overload. This study intends to compare the CPU, memory, and disk utilization of three load balancing algorithms. The architecture and code of each algorithm would either be provided by the author or recreated in Python based on pseudocode present in the article and will be simulated in Virtualbox. Then using python's virtualbox api, the simulation will run for 24 hours.

RNA Secondary Structure Prediction

Noah Simcox

Mentor: Dr. Dr. Asamoah Nkwanta
Department of Mathematics, Morgan State University

Bioinformatics involves utilizing computer programming to analyze biological data and tackle challenging problems in the field of biology. Specifically, this project aims to develop an algorithm to analyze the folding of Ribonucleic Acid (RNA) structures with sequence length 17 or longer via a Java program. RNA begins as a linear sequence of base pairs, created from combinations of the bases adenine (A), guanine (G), uracil (U), and cytosine (C). The program begins by looping through the given RNA sequence and setting pairs of {A, U} and {G, C} while storing them inside a 2D array (lists of lists formatted in a grid shape) for each combination of pairs in a given sequence. This format allows the program to rigorously find every potential RNA secondary structure and safely store it in the established 2D array. Even small changes in the way an RNA sequence folds can alter its behavior and function, so by predicting every possible secondary structure there can be a complete list of potential functions of a given RNA sequence in a cell. These results work as a tool to enhance the research of rare diseases or unknown physiological functions, furthering our understanding of microbiology.

Feedback Loops in Kernel Density based Predictive Policing

Gavin Tantleff

Mentor: Dr. James Foulds | **Supervisor:** Kiran Prabhu and Samin Semsar
Department of Information Systems, University of Maryland Baltimore County

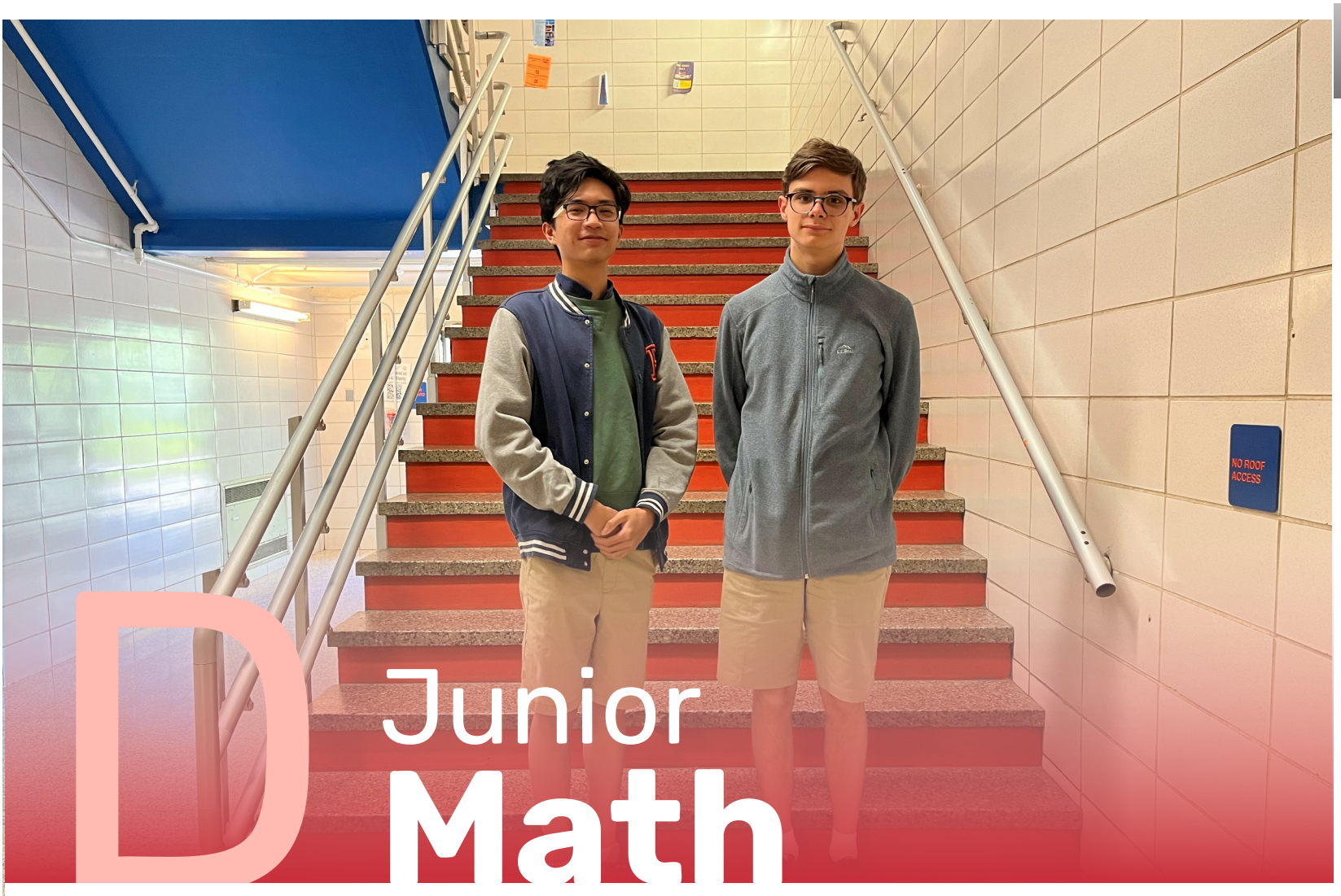
Predictive policing, predicting where crimes will happen and sending police officers there in advance, has become incredibly popular across the United States. Many police departments across the United States have implemented predictive policing models in order to make their operations more efficient. Police departments have justified their usage of these programs by stating that they have none of the biases that humans have when assigning officers, but in reality many of these programs have not been tested and they may demonstrate bias. My team's goal was to examine the bias within a specific style of predictive model, called kernel density predictive policing, which gives departments a heat map of predicted crimes. Using the Python library sklearn, we built a predictive policing model similar to many that are being used today. By simulating the effects of the algorithm over 12 months, we were able to analyze its bias. Results showed the model clumping police officers together, intensely targeting small areas of the city, demonstrating a clear bias within the algorithm. Despite crime being spread through almost the entire simulation, the model quickly targeted certain areas and became only more focused as the model continued. In practice, this will cause certain areas to be overpoliced, usually areas that were already very overpoliced.

A Comparative Performance Analysis of Various Intrusion Detection Systems

Vahe Zaprosyan

Mentor: Dr. Mohamed Eltoweissy
Department of Computer Science, Morgan State University

Due to ever-evolving cyber threats and attacks, all internet engagement poses a risk for electronics. It is essential to develop effective cybersecurity methods to combat this issue. Intrusion Detection Systems (IDSs) play a critical role in ensuring the security and integrity of computer systems and networks. These systems identify and block malicious traffic through monitoring patterns in the network for suspicious activity. Thus, IDSs are vital to protecting an organization's data from cyber-attacks and data breaches. IDSs can also extend to individual devices, as they are able to protect any vulnerabilities which could lead to potential financial or reputational damage. As there are several different IDSs, the effectiveness of each system must be evaluated in order for individuals and organizations to choose the most effective system depending on their unique situation. For example, priorities may be focused on detecting a specific type of threat. If an organization is more concerned with a specific attack, such as malware, then an IDS that can detect anomalous behavior may be more useful. My research compares the performance of various IDSs, which would allow people to make more informed decisions about their network security.



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Junior Math

LEFT TO RIGHT
Josh Tagle, Antonio Romerio

Mathematical abstracts are submitted by Ingenuity students participating in summer research or pursuing individual mathematical studies. Students use mathematical modeling and formulas to conduct their research for presentation at the symposium. Students completing mathematical abstracts attend college-level math classes at Johns Hopkins University. These classes include Linear Algebra and Differential Equations as well as Multivariable Calculus.

Multivariate Interpolation in Synthetic Photometry: Predicting Undiscovered Stars with Artificial Ones

Josh Tagle

Mentor: Dr. Massimo Robberto, Dr. Giovanni Strampelli
Space Telescope Science Institute, Johns Hopkins University

As instruments for celestial observation continue to get more precise, theoretical astronomers must identify efficient methods to derive predicted data from our given models. Star systems or clusters may prohibit the isolation of a particular spectra, and significant processing storage is required to account for the distortions of using practical instruments; thus through the practice of multivariate interpolation, we adapt our own research data through the sole use of artificial stars. We model spectra arguments, including flux, logg, luminosity, metallicity, and age, as unique variables of a vector-valued function, collectively denoted as isochrons. We identify predicted flux magnitudes by interpolating the four closest isochrons to our needs and iterating over several telescope bandpasses to form a comprehensive database of theoretical data. In the future this methodology will be employed to perform systematic analysis on novel stellar formation datasets from the James Webb Space Telescope (JWST).

Fibonacci Numbers and the Golden Ratio

Antonio Romerio

The Fibonacci Sequence – the apparently simple pattern of adding consecutive numbers to generate new ones – is well known for containing within it a treasure trove of mathematical secrets, from a hidden connection to the Golden Ratio, an important constant in geometry and number theory, to seemingly random appearances in nature and architecture. But what exactly do we know about 1, 1, 2, 3, 5, 8, 13, 21, 34,...? In this presentation, we will discuss some of the most important theorems relating to the sequence, as well as an insight into how mathematicians go about discovering and proving these theorems. We will be able to show that some facts – however mysterious on the surface – can often be demonstrated with surprising clarity. The Fibonacci Sequence will, in exploring it, reveal the importance of improvisation, creativity, and the abandonment of rigid rules in the pursuit of mathematical truth.

E Sophomore Research

LEFT TO RIGHT

Top Left Image

William Allen, Lia Brown

Bottom Center Image

Bryan Hijam, Nadiat Adedoyin, Pierre Dugan, Lillian Adams, Sawyer Benhart, Damario Bunch, Jack Serpick, Pierre Vigues, Jade Riddick

Top Right Image

Aydin Mokaddem, Gabriella Washington, Alyssa Goldenberg, Leo Micah-Jones

Not Pictured: *Mia Sproge, Helena Solefack*

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

Understanding and Mitigating the Risks of Bat Borne Virus Transmission

Lillian Adams

My research focuses on the public health impacts of the spillover of zoonotic diseases from bats. Despite being the second most diverse mammalian group, much is still unknown about these animals and their ability to foster the spread of pathogens. One advancement in biological science to reduce these impacts has been vaccines. For example, a vaccine was developed to prevent henipavirus infection in horses, and is even being considered for use in humans. Applied math is also used to predict the spread of bat borne viruses, informing us about how to take better preventative actions. One study I read estimated the median number of people infected with SARS coronaviruses per year in Southeast Asia and created a map of infection hotspots. Although this issue affects many people, startlingly little research has been done. I hope my research inspires more funding to be allocated towards this issue, leading to more data being collected. To continue my research I will investigate infectious diseases under an epidemiologist at Johns Hopkins School of Public Health.

Social Conformity and its Societal Impacts: Can We Be Independent?

Nadiat Adedoyin

Social conformity has been at the forefront of human interactions both in person and online. To conform means to change your initial behaviors or values to meet the attitudes and expectations of others. Patients of diverse backgrounds often experience improper medical care as a result of healthcare professionals responding to environmentally-rooted biases. Social conformity is a societal norm that has influenced our own sense of independence and decision making. Political partisanship and the influence to engage in reckless spending habits have been some of the most prevalent products of conformity today. Using machine learning, one study found that Twitter-generated responses catalyzed political polarization between partisan beliefs. The use of neuroscience has helped explain these ideological disparities. Cognitive research has shown that event-related signals in the brain are linked to how individuals internalize external stimuli. This connects to how we process our actions as potentially beneficial, and our likelihood to conform to receive those benefits. The research in this project can be used to gain a greater perspective on how our biases impact the world and diverse groups of people around us. I plan on continuing my research in the field of neuroscience as part of the Research Practicum.

Using Applied Statistics and Neuroscience to Dismantle Systemic Racism in Drug Policies

William Allen

For decades, people with opioid use disorders have faced discrimination; however, poor and/or addicts of color have borne the brunt of systemic discrimination. My project aims to understand how to improve drug policies by examining the racial double standards that exist regarding recreational drug usage. First, I utilized the field of applied statistics to explain the problem by comparing and contrasting drug usage rates, incarceration rates, and rehabilitation rates of addicts of color and white addicts during the 1980s Crack Epidemic and the current Opioid Epidemic. One paper compared crack and cocaine usage amongst different races, observing disparities in drug sentencing as a result of the 100:1 ratio of grams of cocaine to crack needed to trigger a 5-year minimum prison sentence. I also used the field of neuroscience to help understand this problem by looking at effective treatment methods for opioid dependence. Studies acknowledge relapse as a common step in the recovery process and recommend the drugs methadone or buprenorphine to maintain abstinence. Unfortunately, racial disparities exist in the distribution of these drugs. To combat this, future work may include using machine learning to map out areas that require more methadone and/or buprenorphine clinics. I will be pursuing the Research Practicum, focusing on mechanical engineering to learn more about cancer treatment.

How the Urban Heat Island Impacts the Overall Health of Marginalized Communities

Sawyer Benhart

The Urban Heat Island is a phenomenon in which urban communities experience higher air and land surface temperatures due to several factors, such as heat-absorbing manufactured materials and a lack of vegetation. This increase in temperature and heat intensity can spark and intensify significant health risks among individuals living within the confines of the city. Citizens of marginalized communities who do not have access to resources to mitigate the effects are especially susceptible to these health risks, and finding solutions to this susceptibility is a highly relevant topic in today's world. Ecology is exceptionally pertinent to this research as studying the effects of the Urban Heat Island is looking closer into the way humans affect the environment around them through evolution and increased infrastructure. Environmental engineering is another discipline that could help mitigate some of these effects by using environmentally friendly materials and adapting infrastructure. These detrimental effects directly impact everyone who lives in and around a city, and this topic is vital for prolonging a healthy life. I hope to increase my knowledge by researching the issue at the Department of Earth and Planetary Sciences at Johns Hopkins University with Dr. Darryn Waugh.

How Math and Physics can Contribute to Creating Sustainable Architecture

Lia Brown

The objective of sustainable architecture is to minimize the dependency on resources and carbon emissions of a given space, while maximizing the financial, long-term benefits, as well as the productivity and efficiency of that work space. Sustainable architecture focuses on building a project that will not heavily affect the environment around it. Green building benefits not only the environment but also workers' health. There are certain aspects of standard buildings, like the air quality, that are harmful to the environment and people. Many mathematical and physics principles are used to design and create buildings, meaning a new course and criteria would be needed for creating sustainability. Currently, there is a standardized system called ISO used to determine how sustainable a building is. Sustainability has only recently become a focus for major companies, and many designers and architectural engineers won't implement sustainable advances in their construction because of the extra steps needed to be taken in the process. I hope my research will further the understanding, acknowledgement and development of sustainable architecture. For my Research Practicum, I hope to learn more about astrophysics and astronomy by working with a mentor at the Space Telescope Science Institute.

Improving Agriculture through Technology and Microbiology

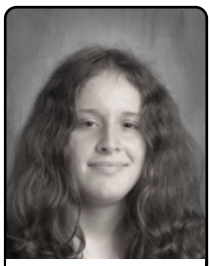
Damario Bunch

Technology has helped improve agriculture by increasing production, profit, and efficiency. However, technology also results in unforeseen drawbacks. For example, precision farming is the incorporation of technology to increase crop yield and maintenance of crops. This form of farming is closely related to digital and smart farming, using spatially-aware sensors that harvest massive amounts of data via automated tractors and drones. Precision farming also decreases the negative environmental impacts resulting from agriculture. It decreases the amount of fossil fuels released into the environment. Additionally, it decreases excess water used in farming and thus waterlogging. Farmers also use agricultural biotechnology and genetic engineering to increase crop production, protection, processing, and nutrients of the crops. Though this technology has benefits, there may be negative impacts. A gene might escape/spread into the environment and taint other crops and animals. which can affect other species and decrease biodiversity. In order to eradicate these risks, we need to work on and address the catalyst to these issues. I will continue my research in the field of chemistry in the Research Practicum. I aim to learn more about chemical reactions through experiments and teachings.

How the Increasing Threat of Gun Violence Damages the Mental Health of America's Youth

Pierre Dugan

Gun violence is an ever increasing threat within American society and its people. With the ever-growing number of life threatening violence in the country, there is certain to be some effects on the people of America, and more specifically, impressionable youth who have grown up watching their own peers die daily. Almost every child is affected by these shooters and the constant threat of gun violence. The numbers are terrifying. In a national survey of adolescents, 5% had seen someone get shot, and 10.9% had seen someone threatened with a gun or knife. Understanding the effect these shooters, and their threat, have on children is a crucial step in knowing how damaging they are and may help put us closer towards doing something about it. Oftentimes, one large piece of this puzzle is ignored, and it prompts the question: how does ever-improving gun technology affect the amount of shootings, and how damaging are they? In 2018, 75% of murders, and nearly half a million other crimes involved firearms. Understanding how increasing firearm technology and accessibility affects the frequency and severity of shootings is a crucial step in stopping it. I hope to pursue medical research through the Research Practicum.



Using Aromatherapy as a Mechanism in Treating COVID-19-Induced Anosmia

Alyssa Goldenberg

One of the most prevalent effects of COVID-19 is anosmia, or loss of smell, which results from damage of the olfactory system. The olfactory system is responsible for sensing and processing smells. Anosmia negatively affects people's quality of life, making it harder to sense danger (smelling something burning, for instance) and weakening smell-associated memory. My research focuses on ways of treating COVID-19-induced anosmia through aromatherapy. Aromatherapy is generally defined as the therapeutic use of essential oils to treat mental and physical conditions. The STEM discipline of neuroscience can help explain the cause of damage to the olfactory system and the specific locations where breakdown in sensory receptors occurs. Prior to researching methodology for aromatherapy, I read articles that diagrammed the olfactory system and highlighted its parts damaged by the pathogen. The STEM discipline of biochemistry can help develop effective combinations of essential oils to be used in stimulating the olfactory system. One study formally tested the use of essential oils in improving COVID-19 patients' olfactory sensitivity. The results of this study indicated that patients with COVID-19-induced anosmia who were instructed to smell essential oils for an extended period of time had improved olfactory sensitivity compared to people who were not given any treatments. The information gathered through this research could further develop treatments for long and short term COVID-19 symptoms, like anosmia, through the use of aromatherapy. I hope to continue my Research Practicum studies in the fields of biochemistry or biology.

Exploring Neuroscience and Chemistry as a Means of Mitigating the Effects of Climate Change

Bryan Hijam

Climate change has been directly linked to the continual decline of the Earth's environment. Identifying and implementing effective, long-lasting solutions toward climate change should be a primary objective of not only scientists but everyday citizens. One means of implementing a solution can come from a neuroscientific standpoint. Specifically, one study explored how dissecting different brain mechanisms allows us to "hack" the dopaminergic system, the system that controls motivations, emotions, etc. within our brains. Understanding this will allow us to implement reinforcement learning within our society as a key tool to promote climate-friendly behavior. In addition, applying and developing synthetic fuels can lead us to an eventual net-zero carbon future. One study explored how we can create synthetic fuels to match the criteria of 100 percent renewable energy for transportation. Exploring systems like Solid Oxide Electrolysis, which utilize waste heat from exothermic reactions to reduce CO2 emissions, could be a possible solution to the climate crisis. Climate variability, rising temperatures, and increased CO2 emissions serve as a detriment to the environment and our quality of life. Implementing solutions such as these can greatly increase the quality of life and the environment. This research can be utilized as an aid to developing hopefully long-term solutions to one of the greatest social issues that impact us today. For my Research Practicum, I will be working with Dr. Jelani Zarif in the Department of Oncology at Johns Hopkins School of Medicine, where I will expand my understanding of biochemistry and gain real experience researching in a lab setting.

Using Neuroscience and Biology to Understand Problems in the U.S. School System

Leo Micah-Jones

My research focuses on problems within the United States school system. Specifically, I apply insight from neuroscience and biology to consider why these problems exist and possible solutions. One problem with our school system is the early start time and heavy workloads, which disrupts adolescents' sleep schedule. One study showed that sleep deprivation can affect one's cognition and thereby also impact the quality of their work. There is increasing evidence supporting the idea that sleep deprivation impacts alertness, vigilance, attention, and severely impacts the creative/problem solving aspects of the brain. Another example is through the school lunch and how the food provided affects students' ability to be present and attentive. The food that schools serve is often considered unhealthy and lacking in nutrients, which can lead to decreased energy levels. My research can lead to a better understanding of how to improve the United States school system. I will be pursuing the Research Practicum in a neuroscience lab that aims to help rehabilitate those who suffered a traumatic brain injury.

How a Better Shoe can help Multiple Sclerosis in the Elderly

Aydin Mokaddem

A recent study from the Multiple Sclerosis Lab places the percentage of multiple sclerosis patients over the age of 65 at 9% in the United States. Those in this 9% struggle when putting weight on their feet. My research aims to learn about potential ways to improve orthopedic shoes to fit the needs of elderly people suffering from multiple sclerosis. Articles show that a primary issue of shoe design is that shoes aren't designed for active elderly. To learn about walking activity among elderly with multiple sclerosis, I researched how this group's feet made contact with the ground. Articles indicated that one of the greatest forces when walking was ground reaction force (GRF), which is the force exerted by the ground on the body and corresponds to a person's weight. Understanding GRF is very beneficial when observing the distribution of weight and potential imbalances when somebody takes a step. In 2017, Colorado University found that the majority of people dealing with multiple sclerosis had muscle stiffness issues. Studies show that these issues can be alleviated with a shoe that can properly wrap around the heel and ankle. This information can inform effective ways to design a shoe for the elderly living with multiple sclerosis. I will be pursuing the Research Practicum and hope to do research in mechanical physics to gain hands-on experience and better understand how multiple sclerosis operates.

How Simulations Can Be The Future of Oceanic Climate Change Mitigations

Jack Serpick

Climate change is a global issue, majorly affecting Earth's ocean through coral bleaching, fish migration, ocean acidification, and more. As researchers have made breakthroughs in data collection, they have been able to learn far more about the impacts of climate change on the oceans. Also, with new discoveries using machine learning, scientists are able to use data to simulate real world scenarios. For example, researchers at the University of Wisconsin collected data from four lakes with varying features and created a simulation. They observed that changes in meteorology would cause consistently higher epilimnetic temperatures and longer ice-free periods. Also, geoengineering can use the outcomes of the simulations to engineer more accurate long- and short-term solutions to the effect of climate change on the ocean. For instance, researchers found that geoengineering, such as surface fertilization with iron and ocean alkalization, can help mitigate lasting effects of climate change. The research presented in this project can lead to new methods for reducing the effects of climate change on the ocean, lakes and other bodies of water. I am pursuing the Research Practicum and would like to learn more about astrophysics, wave physics, and satellite altimetry.

Stereotypes, Misconceptions, and Prejudices of People of Color and its Impact on their Lives

Helena Solefack

Discrimination against people of color (POC) has been a prevalent issue in society and can be seen in many aspects of everyday life. In this project, I examined stereotypes, misconceptions, and prejudices about POC and how they can impact the mental and physical health of POC. A study found that racial discrimination was linked to an increased risk of cardiovascular disease and a higher probability of depression and substance use disorders. I also researched health disparities in healthcare through statistical data. One study concluded that false beliefs in biological differences between blacks and whites are highly common and that racial bias can be observed in treatment recommendations. Surveys found that, on average, 11.55% of medically trained participants endorsed false beliefs about biological differences. Of those that endorsed false beliefs, results indicated these participants also showed racial bias in pain perception. Although it may be impossible to completely prevent discrimination, it is still important to work on minimizing it to improve the lives and health of POC. This research will increase understanding of the impacts of racial discrimination and help find ways to mitigate its occurrence. I will be pursuing the Research Practicum in hopes of researching ways to aid disadvantaged populations through health advancements.

Observing Patterns of Behavioral and Genetic Warning Signs for Alcoholism

Mia Sproge

Alcoholism is a disease surrounded by centuries of stigma, making it difficult for people to receive or seek treatment. However, even with treatment, alcoholism is an incurable disease. Genetics and statistics can inform us who is more likely to be impacted by this disease. However, racial, income, and socioeconomic status (SES) disparities remain regarding accessibility to rehabilitation or AA meetings. For instance, one study concluded that people of both high and low SES were equally likely to suffer from alcoholism. However, people of lower SES were more likely to suffer consequences and face hardships mentally and physically due to alcoholism. It is important to be able to identify warning signs and early indicators of a genome at risk for alcohol abuse to be able to prevent the progression of addiction. Through data and statistics, scientists can better understand how to identify and manage these signs of addiction before it becomes life altering or lethal. Examining a person's genetic makeup and their parent's history with alcohol is also an important indicator in trying to prevent alcoholism. For example, people who have alcoholic parents have at least a 50% chance of being vulnerable to addiction. I am pursuing the Research Practicum next year and am interested in working with biological science departments.

Exploring the Connection between Organisms and Technology: Enhancing Our Understanding of the World

Pierre Vigues

The relationship between technology and organisms has the potential to create innovative solutions to global problems such as climate change and food insecurity. However, there is a lack of understanding of how these fields can complement each other. Biomimetics and biomimicry are two approaches that have been used to address this problem. Biomimetics draws inspiration from nature to develop new technologies and materials, while biomimicry imitates nature to solve human problems. By studying the structures, processes, and systems found in organisms, scientists and engineers can develop new materials, devices, and systems that can mimic the capabilities of living organisms. These approaches have contributed to the development of various technologies that have helped solve problems in different fields, including medicine, environmental monitoring, and sustainable energy production. The integration of technology and biology has the potential to create innovative solutions to global problems, and further research would have to be done to make this possible. I hope to learn more about marine biology at the Institute of Marine and Environmental Technology (IMET) for my Research Practicum.

Using Microbes and Machines for Sustainable Farming

Gabriella Washington

Adopting sustainable agricultural practices is becoming increasingly significant to slow the declining health of the Earth, as some current practices contribute to water pollution, marine dead zones, desertification, soil degradation, and negative effects on the health of living organisms. Using environmental microbiology, microbes are incorporated into organic fertilizers to improve plant growth because of their ability to decompose organic matter and recycle nutrients in the soil. One study aimed to increase the production of okra by incorporating beneficial rhizobacteria into organic fertilizers like charcoal, press mud, and peat. Machine learning can help improve agricultural practices by helping farmers precisely treat crops, effectively minimizing water, fertilizer, and pesticide waste. Through machine learning, researchers can predict the yield of a harvest. Another study showed that a computer could use images from a field to count the number of coffee fruits growing on a tree and classify them as harvestable or non-harvestable. Researching sustainable agriculture practices can provide several environmental benefits, including improving the health of marine and land animals and their habitats, minimizing the waste of crops, water, and fertilizers, and can lead to more profit for farmers. I am pursuing the Research Practicum and would like to continue working in the field of environmental science. I hope to learn more about the environmental impact that humans have on the world around us and how we can fix them.

Sophomore Innovation

LEFT TO RIGHT

Left Image

Victoria Pitt, Noah McNally, Maxwell Hunt, Sawyer Ross, Matthew Yacobucci

Right Image

Brandon Faison, Tayler Harris, Jaidy Amador

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 pursuing Innovation Practicum will begin learning their respective coding languages this summer. The posters present on the Symposium website represent a first effort to present their research topics to a public audience.

How Lack of Knowledge of Sexual and Reproductive Health plays a role in STI Rates

Jaidy Amador

My project examines how rates of sexually transmitted infections (STIs) are impacted by one's sexual and reproductive health education. One study evaluated the effects of insufficient sexual education on STI rates and testing sites. This study was beneficial to finding concrete solutions to preventing sexual diseases. This research explored global studies explaining how brain development plays a role in appropriate sex education and the likelihood that safe sex is practiced. In addition, statistics were used to demonstrate the role sexual education plays on STI rates. For example, in sub-Saharan Africa there was a study carried out in order to prove the potential effectiveness that sexual education in schools has on STI prevention, notably that of the human immunodeficiency virus (HIV). This field of research can be influenced with more thorough and long-term studies to better understand how knowledge can impact sexual safety. For my Innovation Practicum I am interested in learning about machine learning and how it can be used to spread awareness and help solve problems in society.

Sexism in Video Games: How Neuroscience and Technology can Help Explain the Causes and Effects

Brandon Faison

Video games provide a form of entertainment and community for players. However, first person shooter (FPS) video games are a commonplace for sexism and toxicity. Female gamers, a minority population, are often targets of male toxicity via these online communications. For example, games like Valorant, Rainbow Six Siege, and Counter Strike allow for player interaction, which may result in offensive language towards female players. Insight from neuroscience and technology can help explain sexism in video games. Neuroscience can shed light on motives of competitive players who might resort to negative online behavior. Competitive games can damage the mental state of the player and cause them to be more hostile to those with a skill deficit. Advances in technology can help provide solutions to sexism in video games. For instance, Riot Games's Vanguard Anti-Cheat system automatically bans an account for 4 months or permanently for any offense from using offensive language. Information from this research can help make video games a safe space for all players, regardless of sex. For my Innovation Practicum, I will learn a coding language and apply it to a machine learning project.

How the Incarceration System Negatively Impacts Correctional Officers

Tyler Harris

At the forefront of correctional facilities, and the system itself, Correctional Officers (CO) are consistently put into stressful and traumatic situations that could potentially result in trauma, injury, or death. The main focus of this research is to learn about the ways correctional systems negatively impact the physical and mental health of COs within our society. Currently, COs experience some of the highest rates of post-traumatic stress disorder (PTSD), depression, and anxiety within the workforce. This rate is higher amongst retired COs. Due to the constant stressors within the hazardous work conditions, many COs tend to burn out, which may cause more issues like emotional fatigue and could take a toll on physical health. Some of these issues may take the form of insomnia, chronic headaches, gastrointestinal illness, chronic fatigue, amongst other side effects. More thorough research into the state of our correctional facilities and the resources provided to them may lower the risks associated with managing these facilities. In addition, this research could potentially guide efforts to enhance the rehabilitation aspect of correctional facilities, and improve the job performance of COs as well. With this research, I aspire to bring awareness to this important issue in the hope of enacting change within our system. While participating in the Innovation Practicum, I hope to learn more about computer science and machine learning so I can apply my new skill set in future endeavors.

Understanding Retirement and What to Consider When Retiring

Maxwell Hunt

Due to its substantive late-life implications, retirement is a major concern to many people. Years of planning and saving are required to retire later in life. One STEM discipline that must be considered when retiring is math and statistics, which will help inform one's planning on when and how much is needed to comfortably retire. Actuarial science in particular is especially useful, as it uses statistical methods to assess factors that impact one's monetary risk or safety in retiring. Specifically, this discipline will help determine what factors and financial insurance are required to prepare for retirement. For example, personal investments should be considered when assessing one's plans to retire. These STEM disciplines can help ensure a happy, post-work life. This research aims to give people a better understanding of what retirement is and what one must consider if or when they plan to retire. For my Innovation Practicum, I hope to work with a mentor in the field of math and statistics to better understand and solve a social problem.

Effects of Fracking on the Environment and Surrounding Areas

Noah McNally

Fracking and hydraulic fracking are two of the easiest yet biggest problems to solve in terms of climate change. Fracking releases toxins and chemicals into the environment and sometimes can spread to water sources that humans use. This research explores environmental science and biochemistry to demonstrate that fracking must end or become more eco-friendly. First, environmental science reveals that fracking pollutes the environment through water sources but also opens up pockets of CO2 that are hidden underground. Also, biochemistry has demonstrated that fracking impacts other distant environments through the transportation of chemicals via groundwater. An idea that might be possible in the future would be to use chemicals that are more eco-friendly in order to help preserve the environment around it. Another idea would be to begin fracking on other planets to help prevent further damage to Earth. I am pursuing the Innovation Practicum and will be conducting research in astronomy.

Ecological Effects of Biotechnology: How Genetic Modification of Crops Endangers Human Health and Our Environment

Victoria Pitt

Genetic engineering of crops has become increasingly popular among farmers, and is frequently used as a solution to combat insects and increase crop yields. My research explored the impact modifying the genes of a plant had on the environment around it and the humans that consume it. Ecologically, genetically modified (GM) crops can indirectly lower the lifespan of many organisms. In one article, a study showed that many non-targeted insects have a heightened risk of fatality after consuming prey that ingested modified crops. For example, the green lacewing, after eating live prey that had consumed GM corn, experienced a 62% increase in mortality rate. Engineered crops also impact the health of humans, as allergens are rampant among the introduced genes in food. One investigation exhibited the risks of a transgenic protein added to soybean for animal feed. The protein was rich in methionine, an amino acid found in the Brazil nut, and induced reactions in patients who were allergic to the nut. This research highlighted the risks of genetic modification, as well as the threat of our limited knowledge about how trangenes work. It is crucial that more research be designated to assessing the safety of these crops, and how these changes could affect the environment. I will be pursuing the Innovation Practicum in hopes to investigate statistics and applied math.

The Cognitive and Behavioral Effects of Overmedicating People with Mental Illnesses

Jade Riddick

The overmedication of mentally ill people has become a pandemic in recent years. This issue largely stems from the shift in suggested treatment; medical officials have begun to prescribe intense narcotics instead of reparative therapy. In one study, psychiatrists conducted a survey on doctors in the UK, their perspectives on mentally ill people, and their preferred versions of treatment. Of their sample, 56.8% felt that extensive drug treatments were more effective than cognitive therapy. In another study, researchers probed this issue through the lens of chemistry. One study attempted to find which chemicals in drugs had negative cognitive and behavioral reactions. Next year I hope to conduct research in sociology and statistics to better understand the detrimental effects that medical routines have on people with mental illnesses.

The Cognitive Benefits of Sports and Environment on Children

Sawyer Ross

Sports are vital for the growth and development of children, as there are several mental and physical benefits associated with them. This research investigated the various impacts that sports and surrounding environments provide to children. Cognitive science shows there are numerous mental benefits that sports provide children that help them grow and develop in life. One study showed that while exercising, anxiety and depression levels decrease significantly. This growth is attributed to the teamwork involved with team sports, the leadership involved with sports, and socialization during sports. Environmental science also plays a major role in children's development. Surroundings, such as having access to a green, and nature-like environment further emphasize the benefits that sports give. This research informs about and emphasizes the importance of sports on children's development, both physically and mentally. I will continue researching through the Innovation Practicum. I hope to work with and expand my knowledge of data sciences and other types of applied mathematics.

How Eco-Friendly Solutions Can Reduce the Effect of Batteries on Aquatic Organisms

Matthew *Yacobucci*

As electronics become an ever growing industry, battery disposal, renewability, and eco-friendliness are becoming prominent issues. The effects of battery production and the consequences of improper disposal of the materials used to create batteries are devastating for the biosphere. Specifically, the heavy metals that are used to create these batteries can have catastrophic effects on the cells of aquatic organisms. Studies found that the heavy metals in spent batteries can cause mutations and death in the cells of aquatic organisms like L. flammea, A. cepa, and Pseudomonas sp. Producing environmentally conscious batteries that minimize emissions and waste will lead to a greater preservation of aquatic life. Many alternatives to materials are being developed to reduce the environmental effects of the life cycle of a battery. Separators like cellulose nanofiber paper, anodes like Fe3O4, and eco-friendly redox flow batteries can help lessen the greenhouse gas emissions and toxic effects of current batteries. More efforts need to be taken to regulate the production, disposal, and environmental impacts of batteries. Without government support, batteries will continue to have detrimental effects on ecosystems around the world because of a lack of laws regarding the proper disposal of spent batteries and lack of incentive to produce environmentally friendly batteries. I will be continuing my research in the Innovation Practicum and hope to increase my knowledge in computer science and chemical engineering.

Achievements

College Acceptances

Odin Adams
University of Illinois at Urbana-Champaign
University of Maryland, College Park - Banneker Key Scholar*
St. Mary's College of Maryland
Towson University
Villanova University

Julio Gabriel Alumbro
University of Maryland, College Park - Banneker Key Scholar*
Rensselaer Polytechnic Institute
Towson University
Worcester Polytechnic Institute

Jose Alvarado
Louisiana State University
Morgan State University

David Anderson
The University of Alabama
Hampton University
Howard University
University of Michigan-Ann Arbor*
Morehouse College
Morgan State University
University of Southern California
University of Virginia at Lynchburg

John Angelloz-Dugan
University of Maryland, Baltimore County*
Towson University

Evelyn Blackman
University of Colorado, Denver
University of Delaware
George Mason University
Howard Community College
James Madison University
Kutztown University of Pennsylvania
University of Maryland, Baltimore County
University of Maryland, College Park
McDaniel College
Notre Dame of Maryland University
Penn State University - Main Campus
University of Pittsburgh
Towson University*
University of Virginia
Wayne State University

Hannah Breitmeyer
Loyola University Maryland
University of Maryland, Baltimore County
University of Maryland, College Park
University of North Carolina at Charlotte
Penn State University - Main Campus
St. Mary's College of Maryland
Towson University
University of Vermont

Rohan Budhai
Florida Atlantic University
Loyola university Maryland
University of Maryland, Baltimore County
Morgan State University
Penn State University - Main Campus
Temple University
Towson University

Marcos Calderon
University of Utah*

Lucas Celnik
University of Maryland, College Park
Northeastern University*

Malakai Chinn
Frostburg State University
Morgan State University
Norfolk State University*
Old Dominion University

Mara Coughlin
University of Delaware
Gettysburg College
University of Maryland, College Park
St. Mary's College of Maryland*

Lynn Cure
University of Delaware
University of Maryland, Baltimore County
University of Maryland, College Park (Scholars)*
University of Massachusetts-Amherst
University of Pittsburgh-Pittsburgh Campus
Scripps College
Smith College

Malcolm Connor
Gap Year

Samuel Doroja
Capitol Technology University
University of Maryland, Baltimore County*
Morgan State University
Virginia Tech

Edith Louise Engelke
University of Miami*

Kenneth Estep
Hampton University
University of Maryland, College Park*
Morgan State University
North Carolina A&T State University
Rensselaer Polytechnic Institute
Syracuse University
Virginia Tech

Brandon Franco-Martinez
California Institute of Technology (Questbridge Scholar)*
University of Maryland, College Park

William Grant
Amherst College*
University of Maryland, College Park

Murad Habtu
University of Maryland, College Park*
Stevens Institute of Technology
Stevenson University
Temple University
Towson University

Keyierra Harris
University of Maryland, Baltimore County
McDaniel College*
Morgan State University
Rensselaer Polytechnic Institute
St. Mary's College of Maryland
Towson University

Chloe Harrison
Drexel University
Fordham University*
University of Maryland, Baltimore County
University of Maryland, College Park

College Acceptances

Jaelin Heaggans
Bowie State University
Drexel University
Frostburg University
University of Maryland, Baltimore County*
Morgan State University
Towson University

Jalen Henson
Hampton University
University of Maryland, College Park
University of Miami
Morehouse College
Morgan State University
North Carolina A&T State University
Xavier University of Louisiana

Lashaya Hines
Maryland Institute College of Art
University of Maryland, College Park
McDaniel College
New Jersey Institute of Technology
Salisbury University
Towson University*

Amaya Hollis
Morgan State University
Temple University

Wyatt Holt
Towson University*

Ezra Horwitz
LaSalle University
Morgan State University
Pace University, New York City Campus
Salisbury University*
Towson University

Nicholas Jacobson
Colorado School of Mines
Embry-Riddle Aeronautical University - Prescott*
Metropolitan State University of Denver

Royce Jimenez
University of Maryland, Baltimore County*
University of Maryland, College Park

Azariah Jones
University of Arizona
Florida Agricultural and Mechanical University
Hampton University
Lincoln University
Louisiana State University
Morgan State University*
Norfolk State University
North Carolina A&T State University
University of North Carolina at Greensboro
Temple University

Sai Kurup
University of Arizona
Case Western Reserve University
University of Connecticut
Duke University*
University of Iowa
Penn State University - Main Campus
University of Pittsburgh - Pittsburgh Campus
University of Rochester
Syracuse University
University of Wisconsin - Madison

Eva Lesko
University of Arizona

Yuki Lin
Johns Hopkins University (Cummings Scholar)*

Holland Low
Drexel University
Flagler College
Goucher College
Lafayette College*
University of Maryland, College Park
Penn State University - Main Campus
St. Mary's College of Maryland
Towson University

R'Reeyah Mabry-Francis
Lehigh University*

Donald Meredith
University of Maryland, Eastern Shore* (Ozzie Newsome Scholar)

Ethan McDaniel
Delaware State University*
Hampton University
Howard University
University of Maryland, College Park (Scholars)
McDaniel College
Morgan State University
North Carolina A&T State University
North Carolina Central University
Temple University
Towson University (Honors College)

Jewel Lumpkins
Clemson University
Delaware State University*
University of Delaware
Lincoln University
University of Maryland, Baltimore County
University of Maryland, College Park
North Carolina A&T State University
Penn State University - Main Campus
Temple University
Towson University
Tulane University of Louisiana

Frebruk Mikre
Goucher College
Loyola University of Chicago
Loyola University of Maryland*
University of Maryland, Baltimore County
Penn State University - Main Campus

Tijah Mintz
California State University - Long Beach
University of California-Riverside
University of California-San Diego
University of Maryland, College Park
Morgan State University
San Diego State University
University of Redlands*
The University of Tampa

Ayesha Mukherjee
Dickinson College
University of Massachusetts - Amherst

College Acceptances

Michael Offor
Morgan State University

Carmen Norman
Drexel University
Frostburg State University
Goucher College
University of Maryland, Eastern Shore
University of Maryland, Baltimore County
McDaniel College*
Morgan State University
North Carolina A&T State University
North Carolina Central University
Stevenson University
Towson University

Jaeci Paranilam
Clemson University
University of Delaware
Eckerd College
University of Maryland, College Park*
Lincoln Memorial University
Michigan State University
Penn State University - Main Campus
St. Mary's College of Maryland
The University of Tennessee - Knoxville
Ohio State University - Main Campus
Towson University
Virginia Tech

Sarah Patterson
Case Western Reserve University
Dartmouth College*
Goucher College
University of Maryland, College Park
McDaniel College
Stevenson University

Muhammad Rahim
University of Maryland, College Park*
Morgan State University
Towson University

Kaif Rehman
University of Colorado, Boulder
University of Maryland, College Park
The University of Texas, Austin*

Anthony Isaiah Rollins
Chestnut Hill College
Morgan State University*
North Carolina Central University
York College of Pennsylvania

Julian Alexander Reichelt
Appalachian State University
University of Delaware
Florida State University
University of Georgia
University of Maryland, College Park*
Penn State University - Main Campus

Eden Rhodes
Case Western Reserve University
Columbia University
Florida Agricultural and Mechanical University
Georgia Institute of Technology
Howard University
University of Maryland - Baltimore County (Meyerhoff Scholar)
University of Maryland, College Park (Honors)
Morgan State University
North Carolina A&T State University*
Temple University
Towson University
Virginia Tech

Jordany Roman-Gonzalez
DePaul University
High Point University
Rochester Institute of Technology*

Anna Rousos
University of Delaware
University of Maryland, Baltimore County
McDaniel College
Millersville University of Pennsylvania
St. Mary's College of Maryland
University of Vermont
William & Mary*

Evyenia Rubenight
University of Maryland, College Park
Mount Holyoke College
New York University
Randolph-Macon College

Kaliah Rumber
Frostburg State University
Goucher College
University of Maryland, College Park
McDaniel College

Olivia Sandoval
University of Colorado, Boulder
Colorado State University, Fort Collins
Fort Lewis College
Temple University
University of Vermont*
Virginia Commonwealth University

Nicholas Santiago
American University
University of Maryland, Baltimore County
University of Maryland, College Park*
Penn State University - Main Campus

Dayvonte Smith
Capitol Technology University*
Morgan State University

Cerena Solefack
University of Maryland, College Park*
University of Pittsburgh

Alexander Smith-Burden
Morgan State University*

Skylar Strickler
University of Maryland, Baltimore County
Salisbury University

Kevin Sun
Drexel University
Maryland Institute College of Art
Pennsylvania at College of Art and Design*

Arcana Thomas
University of Maryland Eastern Shore
Spelman College
Towson University*
Xavier University of Louisiana

College Acceptances

Mia Urban
Drexel University
Fordham University
University of Maryland, College Park
McGill University*
University of San Francisco
SUNY College of Environmental Science and Forestry

Daphney Waller
University of Maryland, College Park*
Towson University

Mazario Watts
University of Maryland, College Park
Notre Dame of Maryland University
St. Mary's College of Maryland

Malik West
Morgan State University
Towson University

Hero Williams
University of Maryland, College Park
Northeastern University*
Penn State University - Main Campus

Denmark Woody
Morehouse College*
Temple University
Xavier University of Louisiana

Sorenson Wynn
Belmont Abbey College
University of the Cumberlands
Fairmont State University
Mercyhurst University*
Shippensburg University of Pennsylvania

Harrison Yezzi
University of Maryland - College Park
Rhodes College
University of Richmond*
The University of the South

Stephen Yoseph
University of Maryland, Baltimore County*
Washington & Jefferson College

Iris Zheng
University of Arizona
Johns Hopkins University (Cummings Scholar)*
University of Maryland, Baltimore County
Ohio State University
Purdue University
Towson University

Notable Scholarships

Gates Scholarship: Iris Zheng

JHU Cummnings Scholars:
Yuki Lin and Iris Zheng

University of Maryland Banneker Key Scholars:
Odin Adams,
Julio Gabriel Alumbro

Questbridge Scholar:
Brandon Franco-Martinez

University of Maryland, Eastern Shore, Ozzie Newsome Scholar: Donald Meredith
North Carolina A&T State University, E-Scholars Full Merit Scholarship:
Eden Rhodes

$6,425,974 in scholarships and counting.

STEM Awards

Morgan State University
Science - Mathematics - Engineering Fair

Earth and Environmental Science

1st Place - **Julio Gabriel Alumbro**, 12th Grade: Comparison of Composition Studies of Exoplanets

Honorable Mention - **Kaif Rehman,** 12th Grade: A*nalysis of Small Shelly Fossils and Ocean Chemistry of the Early Cambrian period in the Poleta Formation*

Engineering

4th Place - **Mia Urban,** 12th Grade: How Mudskippers Move in Amphibious Environments

Mathematics and Computer Science

1st Place - **Louis Lapp**, 11th Grade: Integrating Fourier Transformation and Residual Learning for Arctic Sea Ice Forecasting

Biological Science

2nd Place - **Nicholas Santiago,** 12th Grade: Expression of Gal3 within Mouse and Human Models of Alzheimer's Disease

3rd Place - **Iris Zheng** , 12th Grade: *Activity of E. coli CRISPR-Cas System on Insertion and Deletion Off - Target Sites*

4th Place - **Yuki Lin**, 12th Grade: *Understanding how enoxolone inhibits HNF4a and reduces lipoproteins*

Physical Science

Honorable Mention - **William Grant,** 12th Grade: Investigating Relationships Between AGN Output and the ISM

Overall Winner

Louis Lapp, 11th Grade: Integrating Fourier Transformation and Residual Learning for Arctic Sea Ice Forecasting

STEM Awards

Regeneron Science Talent Search Semifinalists

Holland Low, 12th Grade: *The Impacts of Modulating Reaction Time on Active Sensing in Weakly Electric Fish*

Kaif Rehman, 12th Grade: *Analysis of Small Shelly Fossils and Ocean Chemistry of the Early Cambrian period in the Poleta Formation*

Junior Science and Humanities Symposium (JSHS)

Kaif Rehman, 12th Grade: *Analysis of Carbon Isotopic Values and Small Shelly Fossils of the Poleta Formation in the Lower Cambrian*
Sarah Patterson, 12th Grade: *Exploring Adverse Childhood Experiences Among Men who Have Sex With Men*

Mia Urban, 12th Grade: *How Mudskippers Move in Amphibious Environments.*

Iris Zheng, 12th Grade: *Activity of E. Coli CRISPR-Cas System on Insertion and Deletion Off-Target Sites.*

Math Excellence

Since 2001, approximately 40 Ingenuity graduates have attended leading colleges and universities and become professional mathematicians. Ingenuity cultivates students' love of math through preparation for the following experiences. Ingenuity's college-level math course offers topics in Multivariable Calculus, Linear Algebra, and Differential Equations, typically taught in college.

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 can register for one Johns Hopkins University math course per semester without tuition costs and enjoy the advice and mentorship of the Hopkins Mathematics faculty.

Up to 10 students are chosen to be Future Scholars across Maryland annually, and one to four students are from The Ingenuity Project. Our students have enrolled in 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.

Brandon Isbell, Antonio Romerio and Josh Tagle have been accepted into the program for the 2023-24 school year

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Math Club and Regional Competitions

The Ingenuity Math Club, established by now-retired teacher Dr. Goldenberg and continued by Ms. No, provides students opportunities to participate in math competitions outside the classroom to further their mathematical knowledge and study difficult math problems. Students have had the opportunity to participate in competitions such as the American Mathematics Competitions (AMC-10 and AMC-12) and the Maryland Math League.

For the first time, two teams of 11th students prepared for and participated in the **M3 Math Modeling Competition**. This competition pushes students to take a real-world problem and apply mathematics to figure out a solution. This year, both teams of students made it past the Triage phase of judging, placing among the top 25% of submissions.

Team 1: Madison Drummond, Finn Dyer, Antonio Erdas, Ira Geller, Vahe Zaprosyan
Team 2: Brandon Isbell, Noah Simcox, Josh Tagle

Class of 2023

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

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

Malcolm Connor | Mara Coughlin | Lynne Cure | Alexandra Diaz Franco | Samuel Doroja | Ouisie Engelke

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

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

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

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

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

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

Alex Reichelt | Eden Rhodes | Anthony Rollins | Jordany Roman-Gonzales | Anna Rousos | Evyenia Rubenight

Kaliah Rumber | Olivia Sandoval | Nicholas Santiago | Tenard Sheppard | Alexander Smith-Burden | Skylar Strickler

Skylar Strickler | Kevin Sun | Arcana Thomas | Mia Urban | Daphney Waller | Mazario Watts

Hero Williams | Denmark Woody | Sorensen Wynn | Harrison Yezzi | Stephan Yoseph | Iris Zheng

Class of 2024

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

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

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

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

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

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

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

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

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

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

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

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

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

Zari Wheeler-Oluwagbenga | Cerenity Wilcox | Mahalia Williams | Vahe Zaprosyan

Class of 2025

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

Jaidy Amador | Sawyer Benhart | Tamarra Berger | Samuel Boldon | Teddy Bridgeford | Lia Brown

Mina Brunelle | Da'Mario Bunch | Aidan Carter | Josue Castelan | Sophia Chacko | Myron Crowder

Pierre Dugan | Brandon Faison | Canaan Fitzgerald | Leonardo Franco-Martinez | Tuck Gauvin | Madeleine Gedansky

Salloni Gill | Francis Gittens | Alyssa Goldenberg | Maya Goodwin | Jazmine Green | Leia Griffin


Tyler Harris
Bryan Hijam
Ayanna Hill
Kassia Hughes
Maxwell Hunt
Kaila Jenkins
Emily Kelly
Mckenna Lam
Bee Lipson
William Malone
Kennedy McCray
Hafid McIntyre
Noah McNally
Leo Micah-Jones
Aydin Mokaddem
Brian Muher
Chidubem Okoronkwo
Bennett Okororie
Joseph Okororie
Mekhi Onque
Margaret Paulk
Wryen Pender
Marquell Perry
Victoria Pitt
Sukarno Richardson
Jade Riddick
Yamely Rodriguez
Amber Roller
Sawyer Ross
Aiyana Savage
Kaitlyn Seldon
Jack Serpick
Rishi Shah-Nelson
Malik Singh
Brazil Smothers
Helena Solefack

Mia Sproge | Niko Stevenson | Caleb Streat | Aidan Talley | Samuel Valcarcel | Pierre Vigues

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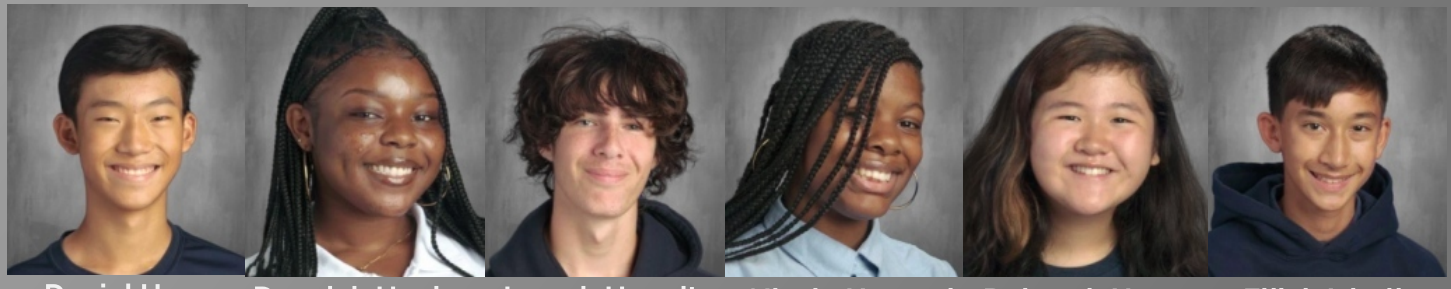

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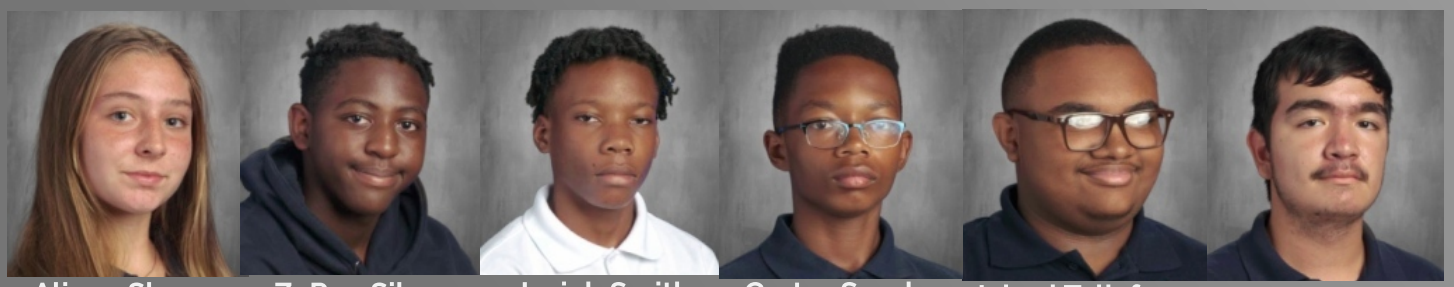

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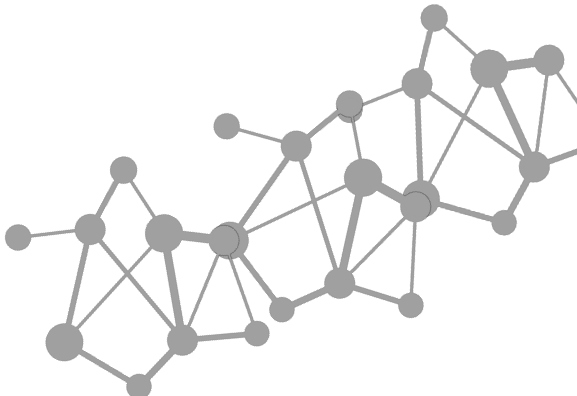

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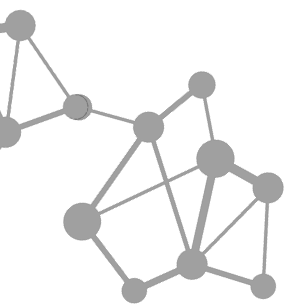

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