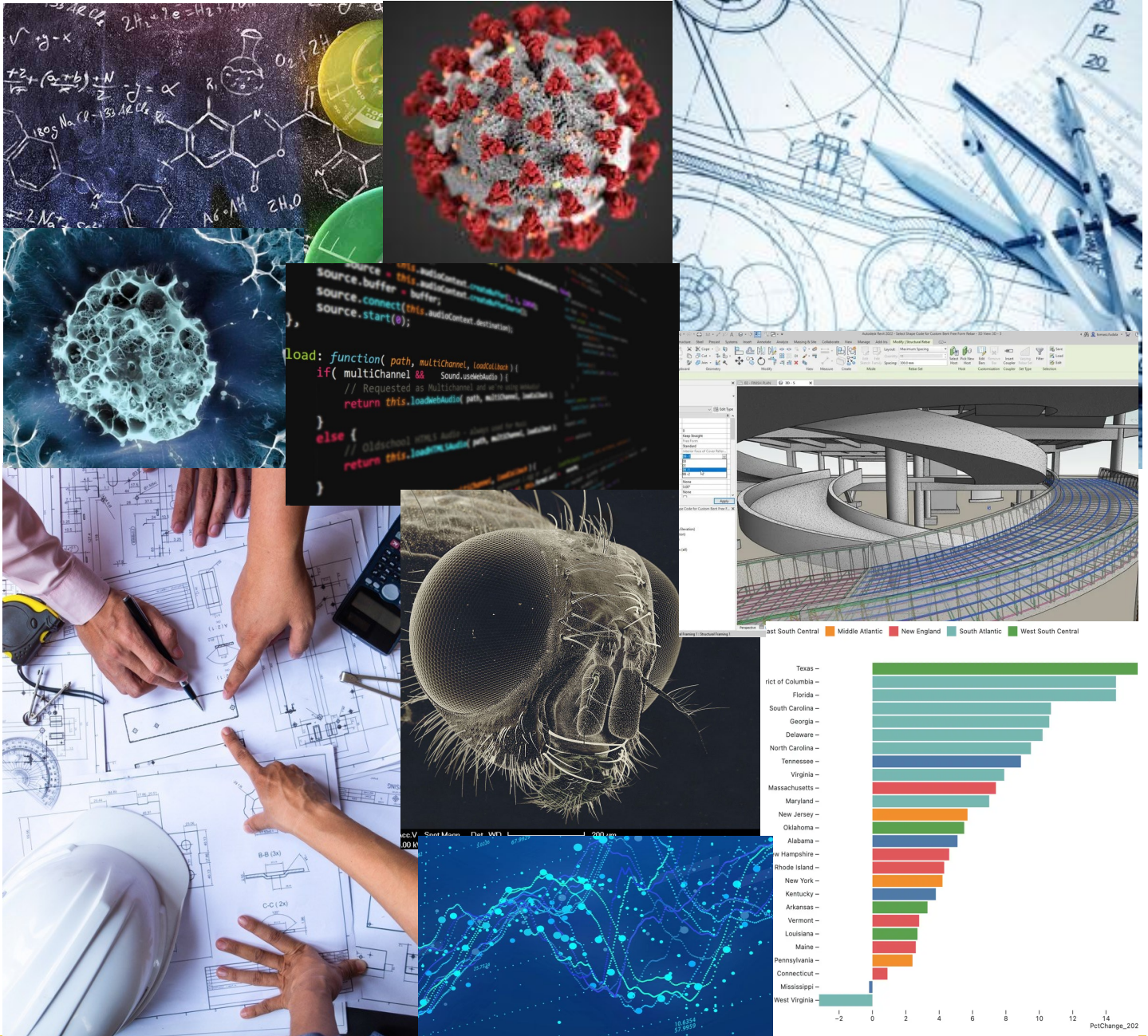




# THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY



## 2023 Science Research Journal

# The Trauma Informed ACEs Screening and Intervention Evaluation Project

## Abstract

*“Despite evidence that ACEs can have detrimental effects on development, there has been little work done to prevent or mitigate ACEs...”*



**Sydney McAlear**  
Smithfield High School  
Isle of Wight County

Adverse childhood events (ACEs) is a specific category of traumatic experiences that children may face during childhood. Prior research has indicated a correlation between experiencing ACEs and having a greater disposition for certain diseases, mental illnesses, and risky behaviors later in life. Despite evidence that ACEs can have detrimental effects on development, there has been little work done to prevent or mitigate ACEs exposure during childhood and adolescence. The TASIE Project developed a screener for pediatric patients to identify children who have high ACE scores, and thus a higher risk of experiencing ACEs-related complications. The screener asked the guardians of pediatric patients to indicate the total number of ACEs the child has experienced from a list of common ACEs provided, and an ACEs score was calculated and treatment and referral options were offered to high-risk patients. Results of the study indicate a very good response rate, with over 70% of eligible patients completing the screener in five of the six reported cycles. Every patient screened was offered education regarding the seven domains of wellness, and every screened patient was offered toxic stress education in five out of six reported cycles. Results suggest that de-identified screening can be efficient and effective when coupled with patient education. While further studies should make a point to consider the long-term effects of screening and interventions staged in childhood, current practices offering education and support to families of children with high ACEs scores are vital steps in protecting the well-being and general health of future generations.

The mentorship process has given me the incredible opportunity to get a head start on developing professional skills. I have felt a great sense of accomplishment knowing that I was able to take part in such an impactful project addressing mental and developmental health for the future generations.

Sydney will be attending Christopher Newport University



# Calibrating Sensors with a Raspberry Pi 4 Microprocessor to Analyze Volatile Organic Compounds and Secondary Organic Aerosols in the Atmosphere

## Abstract

The atmosphere is composed of particles called aerosols, with a special class of aerosols called secondary organic aerosols (SOAs) and known to affect atmospheric health. Another compound called volatile organic compounds (VOCs) affect atmospheric health and form SOAs when they are consumed in complex chemical pathways. The exact composition of the atmosphere is unknown, preventing global policies regarding climate change to be made. Drones are used to collect data on aerosols and particles through adding sensors capable of measuring their concentrations. This research project adapts drone technology to a Raspberry Pi 4 Microprocessor to calibrate the sensors for data collection. Data was collected at the Mathscience Innovation Center in Richmond, VA and NASA Langley Research center in Hampton VA and compared to official data posted by the Virginia Department of Environmental Quality to create calibration curves and an equation to calibrate each sensor. The particulate matter sensor and temperature values were relatively accurate, but the humidity values and ozone sensor were determined to need more calibration. More data collection needs to be done to verify the accuracy of the calibrations and ensure that any future data collected is accurate. Once each sensor is calibrated, data collection with a drone can be done at different spatial and temporal dimensions to analyze the characteristics of SOAs and VOCs to aid in protecting environmental health.

Working with Dr. Kidwell and his research group has been a wonderful opportunity. I am honored to be a part of this research and work on designing a device that can measure the concentrations of these compounds so that more data can be collected to aid in preventing any damage that occurs from these compounds.

*“The exact composition of the atmosphere is unknown, preventing global policies regarding climate change to be made.”*



**Hailee Miller**  
Warwick High School  
Newport News Public Schools

Hailee will be attending Hampton University

# An Evaluation of ROMTech Guided Therapy in Restoring Knee Range of motion After a Total Knee Replacement (TKR)

## Abstract

*“Using a goniometer, a tool for measurement, the patient’s knee range of motion and pain threshold from a scale of 1 to 10...”*

Total knee replacements are one of the most common orthopedic surgeries performed in the United States. After surgery, therapy options are made available to the patient to ensure they restore optimal range of motion and reduced pain. Without proper therapy, the knee will lose range of motion and has the possibility to permanently lock up and become stiff and immobile due to scar tissue. ROMTech Guided Therapy device is a therapy option that is used to digitally guide a patient through recovery. Patients who receive a total knee replacement in the year of 2023 were either be ROMTech patients or not and were categorized based on that criteria. Using a goniometer, a tool for measurement, the patient's knee range of motion and pain threshold from a scale of 1 to 10 was collected. The range of motion along with the pain scale was compared to evaluate if one group had a higher range of motion improvement paired with a lower pain threshold. This research analyzed how beneficial ROMTechs Guided Therapy was in restoring a 0°-120° range of motion and reducing pain during recovery.



### **Kennedy Hood**

Bethel High School  
Hampton City Schools

“This mentorship opened my eyes to the orthopedic field and the many different careers in this field. I had not even considered this field of study before this mentorship so I am so glad I had the chance to experience this field. I have learned so much from all the people who work at HROSM and these last six months at my mentorship have been on of my favorite school experiences.”

**Kennedy will be attending Howard University**

# Simulated Aerial Vehicle Automation Assisted by Machine Learning

## Excel catalog of Aviation Documentation

### Abstract

Commercial aviation is growing at an exponential rate, requiring more and more capable pilots and traffic controllers to keep up with the demands. Attempts to combat this issue of limit human resources have used machine learning algorithms to automate both the pilot process and traffic controller's role. Though many of these automation attempts have had success in creating algorithms to simulate the activities of pilots, the presences of vast aviation regulations and rules have been pushed to the side. This research aims to utilize NASA's FAA and UAM (Autonomous Air Mobility) machine learning integrated excel document organizer to create an autonomous flying algorithm that adheres to the important regulations and standards of the aviation world. Through the use of the organized excel sheet, researchers are able to access and view a wide range of official aviation documents that would have previously been unavailable to prior researchers. With success from external researchers in the past in creating an efficient automated flying algorithm, the additional use and application of official aviation documents are predicted to only increase the practicality and efficiency of an automated system. For future use of automated algorithms in piloting passenger planes, adhering to rules and regulations is a main priority. Though a plane may be able to fly itself, doesn't mean it can fly safely according to the rules of the air.

*“For future use of automated algorithms in piloting passenger planes, adhering to rules and regulations is a main priority.”*



“Never underestimate the difficulty of an apparently simple task. More often than not, they'll keep you staring at the same code over and over again till the early morning hours.”

**Connor McGowan**  
Poquoson High School  
Poquoson City Public Schools

Connor will be attending Virginia Tech

# The Effects of Substrate on Thermal and Mechanical Properties of Mycelium Composites: A Proposal

## Abstract

*“If one of the composites prove competitive, it would indicate that substrates have a significant impact on properties of the composite...”*



**Mara Collier**  
Gloucester High School  
Gloucester County Public  
Schools

The changing climate is forcing changes in our production methods and energy usage. One way researchers have been tackling this problem is by attempting to produce materials with a minimized environmental impact, whether it be through changing production methods or the makeup of the materials themselves. Mycelium composites are one of these experimental materials. They are produced with agricultural waste and are completely biodegradable if left untreated. Since these composites are a relatively new material, however, the existing data on them is inconsistent and scattered, likely because a standardized method for producing them has not yet been developed. To help fill this gap, the effect of substrate on the composite's mechanical and thermal properties will be tested. Coconut husk, saw dust, and rye bran will be the three substrates used to produce otherwise identical mycelium bricks, which will then have their thermal conductivity, specific heat capacity, internal bond strength, modulus of elasticity, and modulus of rupture tested. The resulting data will be compared against expanded polystyrene and particle board to determine if mycelium composites could be a viable commercial insulator or semi-structural component. If one of the composites prove competitive, it would indicate that substrates have a significant impact on the properties of the composite, different composites could be idealized for different applications by changing the substrate, and that the material could be viable for helping reduce the environmental impact of the construction industry.

“My mentorship was a great experience that allowed me the opportunity to explore what working as an architect is like. It gave me experience in CAD design, helped me develop the soft skills to collaborate with clients and coworkers, let me experience the day to day workload of an architect, and allowed me to explore topics I was interested in that I wouldn't be able to find in a normal school environment.

Mara will be attending Rose-Hulman Institute of Technology



# Mechanical Properties of Unstructured Raw Material Types

## Abstract

There is a constant search for the improvement of materials within the material sciences. The silk of brown recluse spiders has a flat sticky feature that is unique to a very few species. Using this orientation increases the tensile strength of the material. Using polymers, tapes are made to recreate the different orientation of the silk. Unstructured, raw material tapes are made to compare with structured tape-based materials. Studies have not focused on identifying and experimenting this feature, and instead, focus on the internal structure of the silk, including protein fibrils, junction angles, and the general methods of making tapes using both raw material and structured fiber reinforced composite methods. These raw material tapes are mechanical tested and found to have weaker mechanical properties than structured tapes, reinforcing the idea that the flat structured tapes result in a higher tensile strength, toughness, and overall stronger mechanical properties.

*“The silk of brown recluse spiders has a flat, sticky feature that is unique to very few species.”*



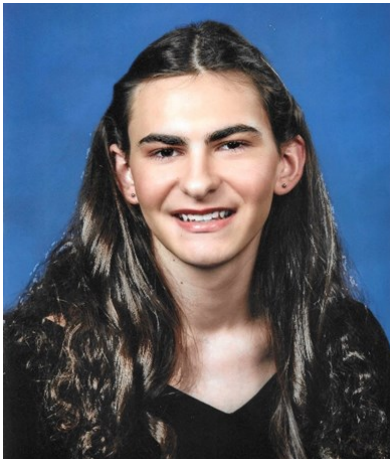
“My mentorship was one of the greatest experiences I have had so far. Working in the lab has initiated my creative thinking skills. When doing original research, I can’t just Google a problem I encounter. I have to try other methods, review other literature, and think outside the box to find an answer. Although this can be frustrating sometimes, it motivates me, even more, to work harder toward a solution.

**Nina Ganeshan**  
Lafayette High School  
Williamsburg-James City County  
Public Schools

Nina will be attending Duke University

# Using a Raspberry Pi Pico to Create a Self-Watering Greenhouse that Regulates House Plant Conditions

*“Self-regulating plant systems exist on the market, but they are very expensive and therefore not accessible to the average consumer.”*



## **Via Miller**

Jamestown High School  
Williamsburg—James City  
County School District

## **Abstract**

The number of people who own house plants has increased. In addition, studies have shown that owning houseplants can improve mental health (Pérez-Urrestarazu et al., 2021). However, many house plant owners struggle to keep house plants alive. Self-regulating plant systems exist on the market, but they are very expensive and therefore not accessible to the average consumer. This research designed a miniature greenhouse that was able to regulate the moisture level in the soil, CO<sub>2</sub> level, and light level. The design was also cheaper to manufacture than similar products on the market. The system uses a Raspberry Pi Pico microcontroller and data from multiple sensors to control these values. The Pi Pico uses this data to control a water pump, LED strip, and door system to keep these values within a set range. This device allows more consumers to be able to afford a self-watering system giving more consumers the ability to own houseplants.

“I learned so much from Dr. Yang and her senior students, Adi and Payton. I knew almost nothing about electrical engineering and coding in python going into this mentorship, but all three of them were patient with me and helped me learn the ropes so I could succeed in this mentorship.”

Via will be attending University of Virginia



# Pansophy: Creating An Accessible Data Management System through ColdFusion

## Abstract

Knowledge Management is crucial for the success of any organization that wishes to expand and grow in the current climate. Knowledge often changes over time so the process to obtain a flexible, yet sturdy system that allows the users of an organization to store information can be difficult to execute, which is why the proposed research aims to answer how knowledge should be stored when working in an organization. The Pansophy team at the Jefferson Lab Facility seeks to address knowledge management by using various software such as ColdFusion, HTML, and Microsoft Excel to create a grid that holds important information such as emails, authors, estimated dates, and document types to efficiently convey information to all of the scientist and engineers working to build a component. Should this software work, it would be a blueprint for many small businesses with a substantial amount of personnel on how to organize general information in an orderly manner.

*“Knowledge Management is crucial for the success of any organization that wishes to expand and grow in the current climate.”*



“This mentorship was one of the most important parts of my senior year because it provided a valuable workplace experience while also exposing me to what my end goal may look like as an aspiring engineer. I will always be grateful for the practical knowledge gained and the communication skills that my mentor, Valerie Bookwalter taught me.”

**Joshua Essandoh**  
Woodside High School  
Newport News Public Schools

Joshua will be attending Virginia Tech

# Time Series Forecasting and Model Validation in Python

## Abstract

*“Out of the models tested, ... a SARIMA model with proper parameters was found to be the highest in score, and lowest in mean squared error and mean absolute error.”*

Domestic traffic comprises nearly 90% of flights in the United States. As such, accurately predicting the flow of air traffic provides helpful insights for industries related to seasonal population flux, and isolating domestic flights removes the additional confounding variable of foreign flights during statistical analysis. In order to exercise this goal, the data was garnered, properly subsetted and cleaned, and a model was chosen based on multiple metrics. Out of the models tested, naive (control), Holt, Holt-Winters, Error, Trend, and Seasonality (ETS) Model, Autoregressive Integrated Moving Average (ARIMA), and Seasonal Autoregressive Integrated Moving Average (SARIMA), a SARIMA model with proper parameters was found to be the highest in score, and lowest in mean squared error and mean absolute error. In certain scenarios, both the ETS and Holt-Winters models outperformed SARIMA. Due to this, the SARIMA model was selected for the time series forecasting of our domestic flight dataset, while the ETS was displayed in the scenarios where it performed well. During the process of testing these models, further points of inquiry were discovered that were not covered in the span of this study; these are discussed in the conclusion.



### Dow Draper

Woodside High School  
Newport News Public Schools

“This mentorship was a great opportunity to learn real world problem solving and the methods for learning outside of a classroom environment. I really appreciate the experience that both the Governor’s School and MITRE have provided.”

Dow will be attending Louisiana State University

# The Effects of Multiple Dosage Space Radiation on Social and Stereotypic Behaviors

## Abstract

Space exploration is an ever expanding field due to the large implications of discovery for life on Earth. Although beneficial in the furthering of science, past studies have found that the Galactic Cosmic Rays (GCR) that astronauts are exposed to during missions have detrimental neurological consequences, clearly evident through behavioral and social tests. The inaccessibility of technology is encouraging researchers to explore the implications of individual particles rather than GCR as a whole. This study demonstrates how double irradiation affects stereotypic and social behaviors in female Wistar rats and therefore employed a double irradiation paradigm. Specifically, video recordings of rats previously exposed to two rounds of radiation were assessed for chosen behaviors to understand neurological effects of ionizing radiation — the data subjected to statistical analysis afterward for comparison measures among the groups. The inclusion of this study regarding female rats and a double radiation dosage allows the research to be applicable to real life situations and model the effects on astronauts. There are no marked differences between the Helium and GCR radiation groups, yet there does appear to be an increase in avoidance and rearing in comparison to the Sham. However, due to the limited data, there is not a sufficient baseline and this comparison is not concrete. As data collection continues, this research may have large implications for companies such as NASA and will encourage further research for complete education toward astronauts to be fully informed of the possible harm of radiation to their health and well-being.

“Mentorship with Dr. Burket provided me with many new opportunities, including forming connections with valuable professors in the field I am interested in pursuing.”

*“This study demonstrates how double irradiation affects stereotypic and social behaviors in female Wistar rats and therefore employed a double irradiation paradigm.”*



**Lia Corning**

Smithfield High School  
Isle of Wight County Schools

Lia will be attending Virginia Tech



# Designing Cryogenic System Layout for the Electron-Ion Collider

## Abstract

*“Particle accelerators have been broadly used for fundamental research in nuclear physics.”*

Particle accelerator is a machine that uses electromagnetic fields to accelerate charged particles inside of beams to very high speeds and energies. These energized particles eventually collide with a target or other energized particles. Particle accelerators have been broadly used for fundamental research in nuclear physics. They are very powerful tools carrying state-of-the art technology to help physicists discover, explore, and understand all forms of nuclear matter. The Electron-Ion-Collider (EIC) at Brookhaven National Laboratory (BNL) is a new particle accelerator project in collaboration with the Thomas Jefferson National Laboratory. The two accelerators, the Electron Storage Ring and Hadron Storage Ring, intersect at several interaction regions, at which particles ejected from the electron-proton collisions strike detectors. Certain critical equipment on the particle accelerator system, such as superconducting radiofrequency (SRF) cavities, need a 2 Kelvin cryogenic environment to work well. The engineering design goals are to work on the equipment layout of three satellite plants, to perform the pressure drop calculation of one cooling water system, and to route the liquid nitrogen (LN2) line from the existing location to a new satellite plant.



**Anson Li**

Bruton High School  
York County School Division

“My mentorship has created an engaging platform for which self-discovery and a standard of professionalism in the field of science can be experienced”.

Anson will be attending Carnegie Mellon

# Modeling the Impact of Nutrition-Sensitive Agriculture with Applications to Smallholder Dairy Farms in Uganda

## Abstract

Many people in sub-Saharan Africa (SSA) have been harmed by undernutrition, making it a serious issue. Individuals in Sub-Saharan households who are unable to get the nutrition they need to be healthy at a young age are vulnerable to stunting, insulin resistance in adulthood, hypertension, and other detriments. Numerous interventions have been used to improve undernutrition, but undernutrition is still increasing in sub-Saharan Africa. The aim of this research is to test the assumptions made about the pathways that connect agriculture to nutrition and to provide an environment in which the effect of agricultural investments and programs on household nutrition can be predicted. An agent-based model was used to predict the probability of stunting in a household. The model created is not able to be used for accurate assumptions stunting. Collaboration is encouraged to find parameters that have an important impact on the probability of stunting.

*“Numerous interventions have been used to improve undernutrition, but undernutrition is still increasing in sub-Saharan Africa.”*

“My mentorship was about creating an agent-based model that could predict the probability of stunting in households in sub-Saharan Africa. I was able to learn computational skills that I may use later in college and my future career. I am very grateful to have the opportunity to work with my mentor, Dr. Smith.”



**Andrew Jones**  
Bethel High School  
Hampton Public Schools

Andrew will be attending Old Dominion University

# Ischemic Stroke Pharmacotherapy: Analysis of Tenecteplase Efficacy Based on Patient's Weight in Comparison to Alteplase

## Abstract

*“Currently, Alteplase is the only thrombolytic that FDA approves for ischemic stroke treatment.”*



**Sona Shah**  
Tabb High School  
York County School Division

Every 40 seconds, someone in the United States has a stroke, and about 87% of all strokes are ischemic strokes, in which a clot in the blood vessels blocks blood flow to the brain, and the tissues, deprived of oxygen-rich blood, continue to degrade. Recent findings show that Tenecteplase, a thrombolytic drug that is approved by FDA for only acute myocardial infarction treatment, results in early clinical improvement and less long-term disabilities compared to the standard stroke thrombolytic care with Alteplase. Currently, Alteplase is the only thrombolytic that FDA approves for ischemic stroke treatment. Since thrombolytic drug administrations are weight based and have a maximum dosage limit, Alteplase and Tenecteplase efficacy in meeting the growing obesity trends in the United States is compared to detect changes based on patients' weight. This is a retrospective observational study initiated to include 35 ischemic stroke patients per each group, but only 19 Tenecteplase patients were analyzed due to time and sampling constraints, while data for 19 random Alteplase patients, treated at Riverside Health System, were retrieved from a national stroke database.

“Through my mentorship, I have gained insights into both medical and clinical research, understanding that it requires both robust primary documentation and clinical evidence to support a controversial change of drugs for optimization of treatments, which can be lengthy and intricate. My mentorship with Dr. Claiborne at Riverside Regional Hospital has deepened my interest in the field of pathophysiology and pharmaceutical research.”

Sona will be attending Virginia Commonwealth University



# Comparing the Effectiveness and Ease of Administration of Tenecteplase (TNK) and Alteplase (rtPA) in Ischemic Stroke Patients

## Abstract

Strokes are the second leading cause of death worldwide and affect millions of people every day, leaving many with temporary or long-term disabilities. To treat strokes, patients admitted to the hospital within only a few hours of their ischemic stroke onset may be administered an intravenous thrombolytic, a “clot-busting” medication that helps unblock the clogged artery. The evaluation of which thrombolytic - rtPA or TNK - results in better patient outcomes and is easier to administer is essential to provide feedback to local hospitals. This study focuses on addressing the demonstrated research gap: there has been close to no implementation of TNK by a hospital system for practical use instead of simply experimental use nationwide, despite its better patient recovery times and greater ease of administration. No evidence was found to support that the TNK sample had significantly decreased mRS and NIHSS values than the rtPA sample. Therefore, the null hypothesis was accepted and it was determined that TNK is equivalent in effectiveness to rtPA. Additionally, TNK was found to be easier to administer by survey respondents, likely because TNK is delivered as a singular bolus rather than a bolus, followed by a pump, as with rtPA.

“I am very appreciative for the many opportunities my mentor provided me to shadow the clinical team during my year-long mentorship. This first hand exposure reinforced my desire to become a doctor. Further, the research I was allowed to conduct has the potential to help improve stroke patient outcomes and well-being, making my mentorship an impactful experience.”

*“Strokes are the second leading cause of death worldwide and affect millions of people every day, leaving many with temporary or long-term disabilities.”*



**Hannah Bunting**  
Kecoughtan High School  
Hampton City Schools

Hannah will be attending Virginia Commonwealth University

# Conceptual Design for Magnet-Sweeping of Electron Particles in the HALL D KLONG Project

## Abstract

*“Based on this knowledge, the primary goal was to create a conceptual design to sweep a charged particle, primarily an electron, from a photon beamline.”*

A strange quark, a collection of subatomic particles found in a subatomic particle called a hadron, was thought to be one of the fundamental components of matter, and their spectrum was relatively unknown. This strange quark was located at a crucial junction between light and heavy hadrons. In order to gather data several orders of magnitude greater than the current dataset, the Klong project planned to combine the existing GlueX spectrometer with an intense secondary beam of mesons, a collection of basic particles (pion and kaon) made up of a quark. The Klong project benefited from the use of the Hall D beamline, which helped with the advancement of analytical techniques and magnet technologies for evaluating the effects of magnetic fields on charged particles. Based on this knowledge, the primary goal was to create a conceptual design to sweep a charged particle, primarily an electron, from a photon beamline. In order to sweep the electron particle from the beamline, using a magnet would bend the electron away, resulting in a hand-drawn design of how the electron passed through the magnetic field. Included with the design were the dimensions of the magnet and other calculated measurements.



**Rachel Wells**  
Smithfield High School  
Isle of Wight County Schools

“As a high school student, I had an extraordinary opportunity to engage in high-level research in my field, which was truly a once-in-a-lifetime experience. The mentorship I received during this period has transformed the way I approach engineering challenges in a more professional and sophisticated manner.”

Rachel will be attending University of Virginia

# Using Python to Modify Outdated Tcl Script for the CEBAF Accelerator

## Abstract

The Thomas Jefferson National Accelerator Facility is a well-renowned scientific facility that uses vast resources and technologies to conduct experiments and research. To continue to advance scientific research, the Continuous Electron Beam Accelerator Facility (CEBAF) is constantly upgraded and modified in order to carry out state-of-the-art experiments and produce important results that are needed in order to gain more knowledge in nuclear physics and the world. The CEBAF accelerator contains software applications that control its functions; however, some of these functions were extremely old, and needed to be updated. To do this, the out-of-date applications needed to be updated from tcl (old language) to Python. Also, the codes needed to be modified in order to better suit each function of the accelerator. By improving two software applications, the Signal Averager and Stopwatch, the CEBAF accelerator will continue to modernize technology, research, and the world itself.

*“By improving two software applications,... the CEBAF accelerator will continue to modernize technology, research, and the world itself.”*

“I am so grateful for the opportunity to work with Michele Joyce and Jefferson Labs. Michele Joyce was very supportive and understanding, and I could not have asked for a better mentor. I will be sure to use what I have learned through this mentorship in the future.”



**Arvin Picardo**

Warwick High School  
Williamsburg-James City County  
Public Schools

Arvin will be attending University of Notre Dame



# Pansophy: A Web-Based Data Management System

## Abstract

*“Our team will develop this web application, allowing access to information for an employee’s level of access.”*



**Elijah Smith**

Smithfield High School  
Isle of Wight County Schools

In every workplace, various sectors must communicate with each other. Engineers, researchers, manufacturers, and project managers must have a consistent and stable flow of communication and information, an especially important variable in terms of due dates and work control documents. Pansophy, meaning universal knowledge, is a web-based workflow, product, and document control system to facilitate workplace communication within Jefferson Labs. Currently, Jefferson Labs operates off of a quite outdated and inefficient Excel Spreadsheet based system when such a large facility calls for something much more intuitive. Our team will develop this web application, allowing access to information for an employee’s level of access. After, we will record the number of missed or pushed-back due dates as a means of measuring workflow and communication. It is expected that the frequency of missed deadlines will increase as workers grow accustomed to the new system, but further observation will display an overall increase in productivity and a decrease in these missed deadlines. The design will be catered to the production of the Electron Particle Accelerator, however, may be applied to and adapted to differing workplace environments

“Working on Pansophy was Jefferson Labs new and unfamiliar, and therefore the most enlightening and educational experience I’ve had.”

Elijah will be attending University of Virginia

# Treating Node Positive Breast Cancer with Radiation of the Whole Breast v. Whole Breast and the Surrounding Lymph Nodes: A Comparison Study

## Abstract

Breast cancer is the most frequent form of cancer in women, therefore affecting a large portion of the population. There is controversy regarding the treatment of nodal regions with radiation for women with node positive breast cancer. To determine the optimal treatment, a Pubmed literature search was performed to include past studies from the last 50 years. Comparing the risk vs. benefit ratios will allow a standard of care to be concluded depending on the best treatment plan. Generally, treatment of the nodal regions with radiation decreased the risk of recurrence in those regions. There were conflicting findings regarding the potential toxicity of treating the nodal regions, especially the internal mammary nodes. In general, for women with node positive breast cancer, it is recommended to treat the supraclavicular nodal region, but not typically the internal mammary nodal region. This approach minimizes the risk of cancer recurrence and minimizes the potential cardiac toxicity of treating the internal mammary nodes. Knowledge of this treatment will help breast cancer patients and potentially other types of cancer as well. The research question being answered through this project is: what treatment plan is most effective when assessing the survival rate and recurrence rates of node positive breast cancer patients, doing whole breast irradiation treatment or the whole breast and the surrounding lymph nodes? A standard of care for physicians has not been developed yet because there has been controversy and the options of treatment have not been compared to each other.

This year I have been able to gather hands-on experience in the field that I am thinking about pursuing later in life, radiation oncology. I have really enjoyed being able to learn and know what a day is like to be a radiation oncologist. Also, my mentor and the entire staff I have been able to work with have been extremely nice and helpful and I appreciate how welcoming they all were to me.

*“In general, for women with node positive breast cancer, it is recommended to treat the supraclavicular nodal region, but not typically the internal mammary nodes.”*



**Skyler Parks**

Poquoson High School  
Poquoson City Public Schools

Skyler will be attending Bridgewater College

# Capability Constrained Monadic Actions for Extensible Secure Programming in Haskell

## Abstract

*“The proliferation of open-source software... has made software development more reliant on components written by third parties...”*



**Benjamin Larrieu**  
Warwick High School  
Newport News Public School

The inclusion of vulnerable or even malicious code within software systems has led to significant cybersecurity issues. The proliferation of open-source software along with the existence of tools such as npm, hackage, or PyPI has made software development more reliant on components written by third parties; while this is obviously often beneficial, it can increase the chance that malicious or vulnerable software is inadvertently introduced into a program. To protect against this, a library is introduced that utilizes features of the Haskell programming language to protect from potentially malicious or vulnerable code that is included within a software project. The type system of Haskell is used to encode what capabilities a sub-component of a program requires and to validate that the user of that component has given permission to perform those actions. This extends prior work on the application of Haskell’s type system to cybersecurity and may include techniques that are applicable to other programming languages.

“My mentorship at MITRE was an excellent experience. It enabled me to learn from professionals actively engaged in the fields of cybersecurity and software engineering. The ability to work alongside these professionals has, I believe, helped to set me up for future success in these fields.”

Ben will be attending Virginia Tech



# Potential Impacts of Living Shoreline Installation on Estuarine Fauna at Gloucester Point

## Abstract

An increasingly popular method of preventing shoreline erosion while maintaining native habitats are living shorelines. Living shorelines consist of protective sills sheltering communities of live marsh plants. These structures provide a diverse array of habitat elements, making them home to a higher variety of species than other anti-erosive structures such as seawalls, whose installation can destroy important vegetated marsh habitat. This study aims to analyze the existing faunal community of a location at Gloucester Point on the York River, and to predict the possible impact of living shoreline installation on this community. Additionally, few studies look at the long-term faunal shifts of sites before and in the years following living shoreline installation, so the data contained within this study may be used in studies analyzing this site in the future. To analyze the faunal community at this Gloucester Point site, seine sampling was conducted from late summer to spring. The species caught were recorded for each sampling day. This data was used to calculate a Shannon-Weiner Diversity Index to quantify the faunal diversity at the site. Additionally, this study analyzes the habitat preferences of each species present to find if their populations are likely to benefit from living shoreline installation, if they may be detrimentally impacted, or if they are likely to be unaffected. An overall net benefit is expected for the species present at the site. 14 species are expected to increase in population, 9 to decrease in population, and 12 to remain unaffected by living shoreline installation. With living shorelines becoming more widely used, it is important to determine what faunal shifts will result from their creation, and how they can be designed to best benefit the local faunal communities. Future studies at this site are needed to determine the accuracy of these predictions.

“Through my mentorship with Mrs. Nuss at VIMS, I have learned much about public outreach and the life of the Chesapeake Bay. I have established connections with VIMS that I hope to maintain in the future.”

*“These structures provide a diverse array of habitat elements, making them home to a higher variety of species than other anti-erosive structure's...”*



**Ian Howard**  
Lafayette High School  
Williamsburg-James City County  
Public Schools

Ian will be attending College of William & Mary

# An Alternative to Ailerons: A Mathematical Approach to a Fuselage Shifting about the Wing

## Abstract

*“Space and air travel are becoming increasingly more accessible and common, but they are still far from perfect.”*

Space and air travel are becoming increasingly more accessible and common, but they are still far from perfect. As preservation of the Earth and the environment becomes increasingly more urgent, it is imperative to explore new approaches to flight which could be more efficient, reducing drag and fuel usage and leading to a cleaner flight with fewer emissions. To explore a new approach, the current method of flight which uses ailerons was compared to an alternative approach: a plane in which the fuselage shifts about the wing in order to create disproportional lift, generating roll with a lower part count and less exterior parts, effectively decreasing drag and increasing fuel efficiency. While it was effective, it was not as efficient as an aircraft that utilizes ailerons, and for this reason, it has been concluded to be an ineffective replacement of ailerons.



**Kevin Sturm**  
Grafton High School  
York County School Division

“Although I learned I do not want to go into aerospace engineering, I definitely learned a lot about the research process. I would highly recommend pursuing research, especially if it is something they are passionate about.”

Kevin will be attending Cornell University

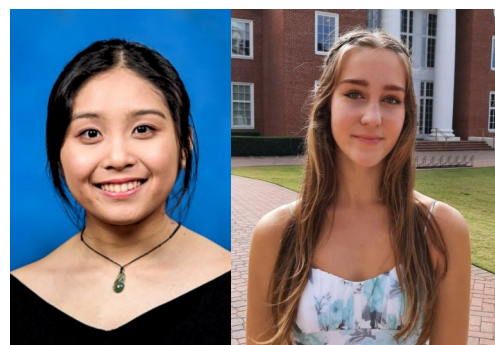
# Potential Impacts of Living Shoreline Installation on Estuarine Fauna at Gloucester Point

## Abstract

The detection of proteolytic activity in vitro is a promising field in understanding and identifying biological processes that occur within living cells. There is little research and experimentation on how to incorporate fluorophores within a polymer system that will allow for the detection of chemical reactions dynamically, hindering the understanding of biological processes in time-specific areas. Opto-active casts are formulated by incorporating DQ-gelatin (dyed-quenched gelatin) in a polyurethane (PUR) network. The DQ-gelatin was conjugated into the network, allowing the polyurethane to act as a cast, 'holding' the protein in place for trypsin (metabolic enzyme) to degrade the DQ-gelatin. When the fluorescein isothiocyanate (FITC) fluorophores in the DQ-gelatin are cleaved by trypsin, the released fluorophores produce a measurable fluorescent emission that can be read via a plate reader. The issue lies in whether this system can be created to view cellular processes in real-time through the controlled environment of the polymer network. Fluorescent polymers, specifically polyurethane, are a promising platform for the real-time detection of protease activity due to their biocompatibility, controllable mechanical properties, and low reactivity with biological molecules. Through an ANOVA test, it was shown that there is a significant difference in the fractional difference between groups with and without trypsin. This acts as a preliminary study to be expanded to other intrinsic fluorophores using proteases important in the regulation and detection of cancer, specifically MMP-9 activity, which can serve as biosensors for biological cues in metabolic pathways.

"Going into the lab to work with a mentor who is an expert in the field of Chemical Engineering and running experiments with tangible results is a very rewarding experience; one that I will be left with for the rest of my life." — Diane Hoffman

*"The issue lies in whether this system can be created to view cellular processes in real-time through the controlled environment of the polymer network."*



**Lillian Lam (left)**

Grafton High School  
York County School Division

**Diane Hoffman (right)**

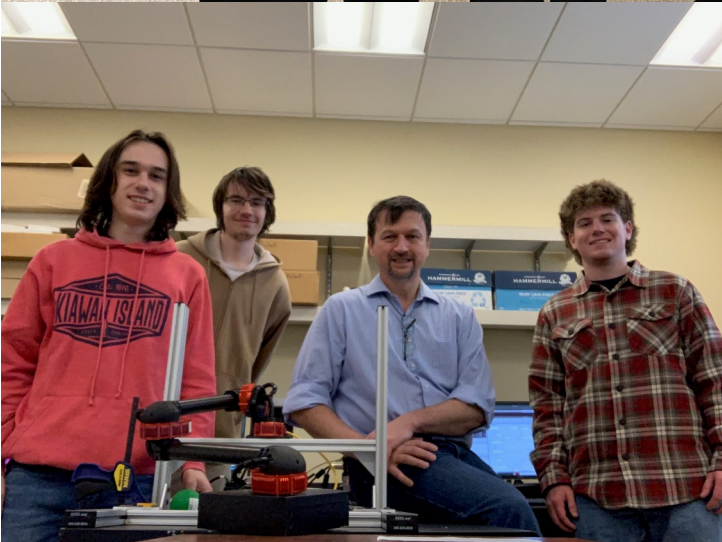
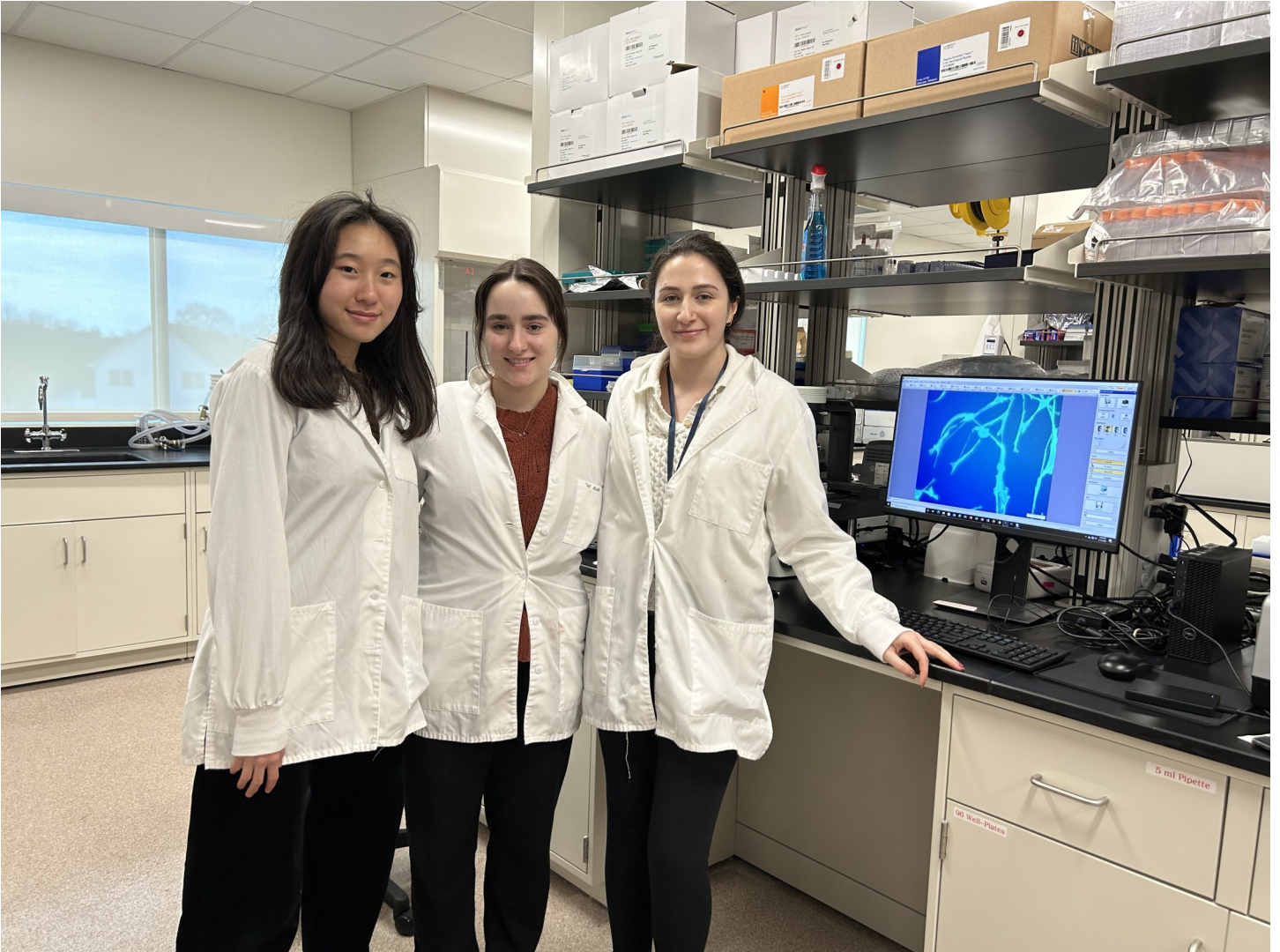
Grafton High School  
York County School Division

Lillian will be attending Johns Hopkins University

Diane will be attending Christopher Newport University



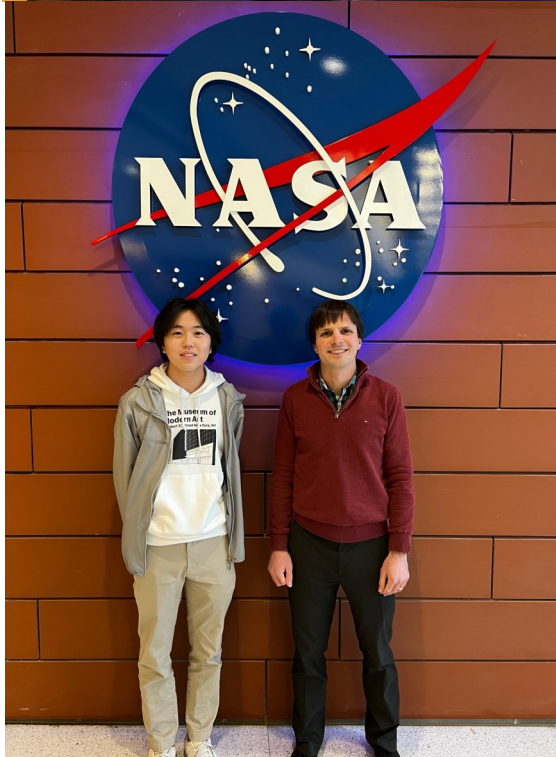
# Mentorship





# Experiences

Both students and mentors were both up to facing the challenge





# THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

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Website: [www.nhrec.org/governorsschool](http://www.nhrec.org/governorsschool)

## Research: Key Component of the GSST Student Experience

A primary goal of the GSST is to provide students with an opportunity to conduct serious scientific research, engineering design, or computer programming projects.

All students take a junior-year course in Research Methods and Ethics, which introduces them to research methodology, statistics, critical thinking skills, and the skills of scientific writing and presentation. In the junior year, all students prepare a science fair project for submission to the Tidewater Science Fair. Students are encouraged to take their work to additional state and national competitions.

In their senior year, students design and conduct a year-long research project under the direction of a professional in their field of interest. The field component is supported by an in-school course which guides students through the entire process, from the selection of a problem to the final presentation. Major aspects of the mentorship experience include: preparation of a formal written proposal for their project, oral presentation of the proposal and a status report at mid year to GSST faculty, a final research document, and presentation of final results to a panel of professionals in appropriate fields at the GSST Spring Symposium. In addition, many students present their findings at local, regional, and national science competitions and symposia. Exceptional work has been published in professional journals.

Research sites that have participated in the GSST Honors Research/Mentorship program included NASA Langley Research Center, Thomas Jefferson National Accelerator Facility, Virginia Institute of Marine Science, College of William & Mary, Hampton University, Christopher Newport University, Virginia Living Museum, local engineering firms, hospitals, and numerous of medical and professional specialists.