



Science Research Journal Spring 2015

GSST Radiation Shield Launched on First NASA Orion Flight

Overview

After a year-long competition among high school teams across the country, evaluators from NASA, Lockheed Martin and the National Institute of Aerospace selected Team ARES, made up of Governor's School students, as the winner of the high school portion of the Exploration Design Challenge. Team ARES worked with the NASA and Lockheed Martin spacecraft integration team to study space flight radiation exposure. The project resulted in launching a radiation shield on the very first Orion mission to space. During the Exploration Flight Test-1, Lockheed Martin hosted Team ARES at NASA's Kennedy Space Center in Florida to watch their experiment launch into space!

Gradiation shielding designed by Team Ares, is one of the most important components that will be evaluated on Exploration Flight Test-1



Anna Montgomery Christopher Dobyns Daniel McNamara Sajan Sheth Abid Rizvi Mr. Greg Hajos, Mentor





"NASA's Orion spacecraft is built to take humans farther than they've ever gone before. Orion will serve as the exploration vehicle that will carry the crew to space, provide emergency abort capability, sustain the crew during the space travel, and provide safe re-entry from deep space return velocities. Orion will launch on NASA's new heavy-lift rocket, the Space Launch System." Taken from ww.nasa.gov

Radioscopic Characterization of End-Use Parts Fabricated Using Fused Deposition Modeling



Louis Rizzi Menchville High School Newport News Public Schools

"My mentorship experience gave me an opportunity to learn useful technical skills and to advance my general understanding of the research process. Collaboration and time management proved to be equally important to the success of the project as knowledge about 3D printing and characterization methods. My mentor, Dr. Godfrey Sauti, helped me find an interesting topic to investigate and was always willing to offer highquality technical and methodological advice. I look forward to continuing to work with him and his colleagues at NASA this summer as an intern to further the development of 3D printing quality feedback. Overall, mentorship has deepened my passion for research and engineering and given me critical experience to help me advance my education and career."

Abstract

Additive manufacturing methods, such as fused deposition modeling (FDM), provide opportunities for quicker, more flexible, and more economical production of goods. However, because FDM is an open loop process, the quality of parts made with FDM cannot yet be guaranteed with the same certainty as the quality of traditionally machined products. Currently, end-use products cannot be made with FDM for applications requiring high precision. Gamma ray radioscopy is a possible approach to feedback and characterization that could make FDM more of a closed loop process. A single axis continuous gamma and beta scanner was built and used to establish accuracy levels for defects of varying sizes. This radioscopic scanning system on the scale of a desktop 3D printer was evaluated to determine if it would provide adequate resolution to detect microstructural defects. With a 5µCi Cs-137 source, features 5 mm wide and 10 mm deep were able to be distinguished, establishing a baseline proof of concept resolution and warranting further development and investigation into radioscopic characterization.

> gamma ray radioscopy is a possible approach that could make FDM more of a closed loop process 77

Effectiveness of Current Diabetes Health Literature in Vulnerable Populations

66 inadequate health literacy is a growing problem and considered by some to be a national crisis



Haley Province Smithfield High School Isle of Wight County Schools

Abstract

Health literacy, or the ability to obtain, comprehend and follow through on medical instructions, is believed to significantly influence preventable or controllable symptoms of disease. Inadequate health literacy is a growing problem and is considered by some to be a national crisis. Health literacy remains, however, a relatively unexplored component of medical treatment. In the few studies done on health literacy, diabetes has been the disease that was studied because it is a chronic illness, the patient plays a major role in treatment, and failure to manage diabetes may result in a number of severe complications. Populations vulnerable to health literacy-related complications include the elderly, minorities, and low-income individuals, due to factors such as lack of education, learning disabilities and cognitive decline.

To determine the effectiveness of currently accessible health literature, a short, multiple-choice survey, comprised of ten test questions and five demographic questions, was created and distributed among multiple populations. The survey was used to assess whether vulnerable populations fully understand the information presented within a medical pamphlet on diabetes, which serves as a representative sample of current and easily available health literature. The effectiveness of the health literature was measured by the number of correctly answered survey questions. The significant difference in test scores between income levels, age groups, and frequency of internet usage combined with the lack of significant difference observed between diabetics and non-diabetics suggests that the elderly, the impoverished, and those with limited internet usage are more likely to struggle with health literacy than their societal counterparts.

"I am so grateful that my mentorship allowed me to not only participate in ongoing research, but to also aid my community by tackling an ongoing social problem: inadequate health literacy. The knowledge I have gained and the skills I have acquired from this experience are guaranteed to accompany me in my future endeavors. "

Haley will be attending Johns Hopkins University in the fall in pursuit of a degree in Immunology.

Construction of an Electric VTOL Aircraft for Mars Exploration



Erin Clifton Poquoson High School Poquoson City Public Schools

analysis of the final prototype showed it is theoretically capable of flight on Mars



Lawrence Peczkowski-Soto Warwick High School Newport News Public Schools

Abstract

The history of Mars is relatively unknown. Rovers have been sent to study the surface, but lack the ability to explore in canyons and drive over rough terrain. Satellites have been useful in studying the atmosphere, but are unable to land on the planet at points of interest. Mars airplanes have been studied but have never been sent to Mars. An electric aerial vehicle is capable of flying into canyons to study the wall formations and exploring points of interest that may be surrounded by rough surface. Aerial vehicles can also survey large areas of land in a short amount of time. Batteries are rechargeable and the vehicle can autonomously charge its batteries without human intervention.

A prototype aerial vehicle and rover pair were designed and built to test the feasibility of Mars flight. Initial aerial vehicle designs were built and flight tested. The design was modified to lower weight and increase flight performance in low Reynolds numbers. The final prototype was a balsa bi-rotor flying wing controlled by torque -vectoring and RPM modulation of the motors. Analysis of the final prototype showed it is theoretically capable of flight on Mars, supporting the feasibility of flight on Mars with current technology. The VTOL prototype can be pursued by space programs to build similar vehicles for actual exploration. Multiple aerial vehicles would be used to serve different purposes due to the limited payload of the aerial vehicle.

"We are extremely grateful for the opportunity to work with our mentor Mr. David North for our senior year in high school. Our mentorship at NASA Langley Research Center has given us an enormous amount of valuable experience. We got first-hand experience at going through the design process for new concepts, working with people in a professional environment, and learning about aeronautics, specifically for Mars aircraft. On top that, the environment alongside Mr. North was friendly, supportive, and enjoyable. Mentorship provided insight into how research is conducted in business and has helped prepare us for our futures in college and in our careers, which has set us apart from typical high school students."

Erin will be attending Virginia Tech and majoring in Mechanical Engineering. Lawrence will be attending Virginia Tech and majoring in Computer Science.

Optimizing a Thermal Evaporation Deposition Process for Fabrication of Indium Tin Oxide Thin Films

Abstract

Indium Tin Oxide (ITO) thin films have a unique combination of characteristics including high electrical conductivity, optical transparency, and strong adhesion to substrates. These qualities make ITO thin films ideal for applications, such as photovoltaic cells and opto-electronics. ITO thin films can be fabricated by a physical vapor deposition method known as thermal evaporation. The optimal process for thermally evaporating ITO thin films was obtained by measuring the impact of post-deposition annealing temperature on the optical transparency of ITO thin films.

ITO thin films were deposited in a vacuum thermal evaporation system onto glass microscope slides. Each film was annealed in an air atmosphere at a temperature of 300 or 400 °C for 30, 60, or 120 minutes. Transparency increased as the annealing temperature was increased, with the optimal transparency measured at an annealing temperature of 400 °C for 60 or 120 minutes.

these qualities make ITO thin films ideal for applications, such as photovoltaic cells and opto-electronics



"This year I had the amazing opportunity to enrich my education by completing a senior mentorship research project through the Governor's School for Science & Technology at the Jefferson Labs. The lessons and experience I gathered from my mentorship are ones I know I will treasure for years to come. From learning how to operate a thermal evaporator system, to communicating and working with professionals in their field, to applying the knowledge from my classes and partaking in real life research, my senior mentorship project was definitely one of the most rewarding experiences of my high school career."

Miriam Buscher Warhill High School Williamsburg/James City County Public Schools

Investigating Cleavage Timing and Morphology of Viable Embryos Through the Embryoscope

rate of division was significantly higher for embryos that result in successful pregnancies 77



Cinyu Chi Grafton High School York County School Division

Abstract

Multiple embryos are transferred in In-Vitro Fertilization (IVF) in order to increase the probability of pregnancy. Fifty-eight percent of multiple pregnancies involved the use of assisted reproductive technology, and 22 percent of multiple pregnancies caused by Assisted Reproductive Technology (ART) involved IVF. Multiple pregnancies are associated with a variety of health risks for mothers and infants. Mothers are often afflicted by premature labor, premature delivery, pregnancy induced hypertension, pre-eclampsia, gestational diabetes, and vaginal-uterine hemorrhages. Infants are generally born with significantly lower birth weights, undeveloped lungs, and cranial hemorrhaging. Low birth weights and premature delivery are also associated with infant behavioral and cognitive development problems.

Multiple births in IVF are common because multiple embryo transfers increase the chances of pregnancy. The examination of the general timeline of cell cleavage may render multiple embryo transfers obsolete. In this study, time lapse data of embryos that resulted in successful and failed pregnancies were examined at the pronuclear fading time and each cleavage time in order to determine a general timeline of cell cleavage in embryos that resulted in successful pregnancies. Cell division times between successfully implanted embryos and embryos that did not result in pregnancy were not significantly different. However, the rate of division (total cell number/total time) was significantly higher for embryos that result in successful pregnancies. The grades of the embryos were not a reliable indicator of embryo quality because the mode grade for successful and unsuccessful embryos was the same.

"There are a lot of things you can't learn through books alone. Mentorship has given me the amazing opportunity to see and experience things many high schoolers may never have the chance to see. I never expected to become so invested in my research, but being in mentorship and spending hours learning about a tiny facet of science makes it part of you. "

Modeling the Efficacy of a Robot-Assisted Human Response to Tornado Disasters



William Brayshaw Smithfield High School Isle of Wight County Schools

Gois use of unmanned aerial vehicles as well as quadrupedal robots was able to significantly improve tornado response systems and reduce the loss of human lives ??



Sahaj Bhatt Warwick High School Newport News Public Schools

Abstract

The human fatalities that result from the occurrence of a natural disaster are a tragedy that can never be completely avoided. Many human deaths occur after the natural disaster has passed due to ineffective and inadequate response systems. It is apparent that a new, more effective system of attending to human casualties needs to be implemented in the aftermath of natural disasters. Recent technological innovations in the field of robotics offer many promising possibilities that may be effective in improving the way humans respond to natural disasters, thus preventing unnecessary loss of human life. Using the Army simulation software One Semi-Automated Force (OneSAF), two simulations were created to evaluate the usefulness of Unmanned Aerial Vehicles (UAVs) and BigDog robots working alongside humans in a response system for a tornado disaster. The simulations modeled the aftermath of an EF-5 tornado with either a traditional, human response or a robotically-assisted human response to the disaster. A total of 160 victims were randomly placed in the simulation with varying injury severities and visibility levels. The all-human response rescued 48% of the injured victims in five hours, while the robotic response rescued 88% of the injured victims.

HUNCH—High school students United with NASA to Create Hardware



C the adhesive properties of Gecko tape were stronger in microgravity



Overview

GSST participated in the NASA HEXS HUNCH (High school students United with NASA to Create Hardware, Extreme Science program), a national STEM education program run locally by the Engineering Directorate at NASA's Langley Research Center. The HEXS program challenges students to use advanced science and engineering skills to solve ongoing problems related to the absence of gravity aboard the International Space Station (ISS).

Joshua Baylor - Tabb HS, will attend Virginia Tech Kevin Brown - Tabb HS, will attend the University of Virginia Kaelan Hill - York HS, will attend George Mason University Chan Kim - Menchville HS, will attend US Military Academy Julia Smith - Tabb HS, will attend Liberty University

Abstract

Students at the Governor's School for Science and Technology were tasked by the HUNCH program to solve a particular problem that astronauts aboard the International Space Station were experiencing. A robot was envisioned to clean the surfaces of the space station utilizing Gecko tape to adhere to the surfaces in microgravity. Gecko tape is a silicon-based organic polymer with microscopic cilia that attach to a surface using van der Waals forces. A partially automated Gecko tape test rig was developed to determine the efficacy of Gecko tape in microgravity on various ISS surfaces.

The test rig measured the adhesive strength of Gecko tape in terrestrial conditions through multiple tests, and then again in zero gravity. The team found that the adhesive properties of Gecko tape were stronger in microgravity, and that it adhered more powerfully to Plexiglass and passivated stainless steel than anodized aluminum. Plexiglass and passivated stainless steel are smoother than aluminum, providing more contact area with the Gecko tape. Gecko tape will be a safe and effective material to use aboard the space station, as it has a relatively high thermal resistivity, does not outgas, and has potential to be used effectively in many zero-gravity applications.

"It was truly a great experience. We were able to explore what engineers do in their field, outside of the classroom setting. From messy and difficult brainstorming, discussions, and paperwork to confusing and time consuming designing, engineering, and analysis, the team learned a lot about the engineering field and about teamwork. The Zero-G experience was a lifetime experience that we all worked so hard for!"

Comparison of Aquaponics Methods in the Growth of Plants

66 aquaponics has the

has the potential to feed people worldwide using fewer resources than current methods

Abstract

Aquaponics has the potential to feed people worldwide using fewer resources than current methods of agriculture. Research into aquaponics is valuable for accelerating it towards large-scale practice. The media bed and raft methods of aquaponics were compared to determine which is more effective to grow basil and parsley. Two tanks, one for each method, were connected to the same aquaponics system to grow both basil and parsley. Plant heights were recorded once a week, and trials lasted for four weeks. Heights at the end of the experiment were compared using a general linear model ANOVA. Based on the last two trials, the media bed and raft techniques are not significantly different, meaning that aquaponics practitioners should use the most suitable or convenient method given the situation.



Frederick Davis York High School York County School Division

"I learned so much working with Steve Urick at the Virginia Seafood Agricultural Research and Extension Center. Aquaculture was only part of what I experienced; I was able to see what a real research center is like, and learn about things like biosecurity, proper testing methods, and maintaining the workplace. Overall, my mentorship reinforced my interest in marine biology, and allowed me to see that the research at places like the Virginia Seafood AREC really matters and helps people all over the world."

Analyzing Thermal Expansion of Silicon Germanium on Sapphire to Prove Single Crystal Semiconductor Alignment

a huge step toward innovation in electronic devices, solar cells, and the future development of



Celine Stewart Smithfield High School Isle of Wight County Schools

Abstract

Many different factors contribute to technological advances, but semiconductors are one of the most vital aspects. Semiconductors have transformed the efficiency of technology; devices are able to be smaller, faster, and more reliable because of semiconductor development. If germanium impurities were added to silicon, together they would create an improved semiconductor; and, if sapphire was used as a substrate, it could improve the overall performance of the semiconductor and make the semiconductor more useful. Silicon germanium (SiGe) crystals were deposited on sapphire substrates through a process called magnetron sputtering. Magnetron sputtering is a method of physical vapor deposition (PVD) that uses ionized particles to deposit thin layers of materials on a substrate. If the semiconductor is successfully created, there should then be a clear relationship between the temperature and sputtering rate, during the sputtering process, and the quality of a single crystal. A range of temperatures was tested and it was determined that the ideal temperature for creating silicon germanium on sapphire (SGOS) single crystals was between 1000 and 1100 degrees Kelvin. The silicon germanium was found to have a bond to sapphire that resembled the silicon dioxide crystal structure. This alignment was used to calculate if any SGOS single crystals could be created at lower temperature to reduce energy cost. A SiGe cubic crystal structure that can align with a sapphire rhombohedral crystal structure and create a single crystal will lead to a huge step toward innovation in electronic devices, solar cells, and the future development of semiconductors.

"My mentorship at NASA Langley Research Center was the most important part of my high school career. I got experience on machines and software that no high school would ever be able to afford. I feel like I learned more real world skills during my time at NASA than in any of the classes I took at high school. I also had the experience working with professionals that care about where I'm going even after I left. They have already offered to write letters of recommendation to help me when I start applying to jobs myself. I know that the experience I gained from this mentorship will help me in the future." Identifying Risk Factors for Autism Spectrum Disorder

preemptive
care has been
shown to
ameliorate the
severity of the
disorder ??



Logan Brich Smithfield High School Isle of Wight County Schools

Abstract

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that is first observed in young children, and is marked by impaired social skills, delayed language development, and abnormal behaviors. Early diagnosis of autism is vital to the development of children with the disorder, and early intervention has been shown to cause the remission of symptoms. Knowledge of the factors that contribute to autism would enable medical professionals to identify children that have been exposed to such factors. These children may then be monitored closely for signs of the disorder, and their parents can seek early treatment if symptoms present.

To determine which risk factors are related to autism, an online survey was sent to the email addresses of parents whose children have been seen at The Children's Clinic in the Hampton Roads region of Virginia. The survey was also made public online. The survey asked parents information about their children, including: whether any children have autism, demographic information such as sex, age, and ethnicity of the children, and whether the children have been exposed to certain environmental factors such as pregnancy or delivery complications, as well as neonatal hospitalization or illness. Responses to the survey were recorded and analyzed using a log-linear three-way contingency table statistical analysis and Chi-square analyses. Odds ratios were calculated for gender and maternal age. Autism was observed more frequently in boys and children who had been exposed to environmental factors than in children who had not been exposed to the same factors. Discovery of the link between environmental factors and autism in children may better enable healthcare workers to assess the risk of each child for an ASD diagnosis. Children that have been exposed to these factors may be encouraged to seek preemptive care, which has been shown to drastically ameliorate the severity of the disorder in young children.

"Over the course of my senior year at the Governor's School, I worked with Doctor Thomas Koerner, a pediatrician at the Children's Clinic of Newport News. When I met Dr. Koerner for the first time, I approached him with a limited knowledge of medicine, but a desire to learn as much as possible during the year. Although initially intimidated by working in a professional setting, I quickly adapted to the environment at the Children's Clinic. Having Dr. Koerner as my mentor was both a privilege and an honor, and collaborating with him throughout the study provided me with invaluable exposure to the medical field. His guidance and support helped ensure the success of the study and fostered an atmosphere of mutual respect. The gratifying experience of conducting medical research at such a young age, as well as the the generosity and warmth shown to me by Dr. Koerner and everyone at the Children's Clinic, have only affirmed my interest in the medical sciences. I am forever indebted to the Governor's School for providing me with such an amazing opportunity."

Potential Uses of Long Endurance Unmanned Air Vehicles to Support Environmental Research

the use of UAV's for observation provides a new perspective on Bay monitoring



Natalie Ricciardi Smithfield High School Isle of Wight County Schools

Abstract

Long Endurance Unmanned Air Vehicles (LE UAVs) are versatile in function and could potentially help monitor the large, seasonal growth of algae in the Chesapeake Bay and the excess nitrogen levels that contribute to dead zones. All plants rely on the nutrient nitrogen to grow and reproduce; however, when nitrogen is present in abnormally elevated amounts, it promotes the over growth of aquatic algal species. Excess nitrogen is a serious threat to the Chesapeake Bay economy because it causes algal dead zones; aquatic regions that lack enough dissolved oxygen to support life. If the Bay continues to drop in biomass output due to these dead zones, the economy that thrives off of harvesting its resources could fail also.

The Orion LE UAV was modified in concept, to include two smaller vertical takeoff and landing (VTOL) drones along with hyperspectral imaging and LIDAR (light detection and ranging) instrumentation that can detect ocean color and the presence of various hydrosols. A UAV flight mission was then designed which surveyed the entire bay and its tributaries. A complete cost analysis was done for operation during the months of May through August, the peak season for algal presence in the Bay. The use of UAV's for observation provides a new perspective on Bay monitoring that includes nondestructive analytical methods and a more consistent and accurate data feed.

Using UAVs to provide data for environmental research could prove to be the next step in uniting research efforts and detecting more precise patterns in algae growth and movement. Ultimately, LE UAVs could be used to monitor and protect the Chesapeake Bay and the economy based upon its resources.

"During my senior year at the Governor's School, I was granted the privilege of access to some of the most meaningful and educational opportunities to date. Alongside the learning done in the classroom with willing experts, my mentorship experience with Craig Nickol at NASA Langley Research Center gave me my first glimpse of what working in a scientific engineering environment is like. Under Mr. Nickol's guidance, I was free to conduct library research and use what I gathered to creatively propose solutions to real world problems, something that proved to be a gratifying experience for me at such a young age. The collaboration I did with other engineers and scientists made it apparent how important everyone's piece of the puzzle is when it comes to getting a job done successfully, timely, and with a positive attitude. Both my mentors at NASA and at the Governor's School have demonstrated to me the significance of continuing my education in order to better serve my community and its future."

Constructing an Electronic Database Retailer Simulation



Brett Blackstock Poquoson High School Poquoson City Public Schools

Abstract

Since the birth of the internet in the 1990's, e-commerce has had a major impact on society. The ability to purchase goods and services through an online medium has provided convenience and comfort to consumers everywhere. The practice of making purchases online has led to the growth of many businesses and industries, which would have failed otherwise. It has also resulted in the creation of new forms of currency, such as Bitcoins.

To better understand how e-commerce works, and the impact it has had on modern civilization, a retail simulation for purchasing and selling goods was created. Using a local database to store information, an application was developed that had the ability to read information from and write information to a database. The database stored all information necessary for a successful retailer to run their business, restock supplies, and monitor the number of items sold to establish marketing trends, among other features.

 the internet has also resulted in the creation of new forms of currency, such as Bitcoins

Creating Maps of Gloucester Court Circle Using Geographic Information System



Suyoung Park Grafton High School York County School Division

Abstract

Gloucester County was established in the seventeenth century and has numerous historically important artifacts and buildings. When excavating Gloucester Court Circle under the Colonial Courthouse Enhancement Project, archaeologists discovered a large number of artifacts and several buildings. However, they have difficulty in investigating due to redevelopment of Gloucester Country utility expansions and the lack of historical records for certain time periods. To assist in avoiding conflicts in future construction or improvements and to track archaeological work that has occurred, a base map has been created using geographical information system (GIS). Several layers that display information about utility lines, work done by the archaeologists in the past and future excavation plans have been added to the base map. This map will help the archaeologists to identify areas that need to be investigated and predict what may be discovered.

66 a base map has been created using geographical information system

Brett will be attending Dakota State University and Suyoung will be attending Georgia Tech.

Comparative Advantage among Common Types of State-Based Searches

Abstract

State-based searches are tools used in Artificial Intelligence to find pathways to get to solutions in complex problems. There are many different kinds of state-based searches with varying levels of speed and accuracy. As it currently stands, there is no standard measure of which kind of search should be used in which situation, and there are few places in which programmers can find direct comparisons among the different kinds of searches.

A tool was developed for direct comparisons between the most common kinds of searches. The data were used to provide guidelines about when to use each kind of search. This study measured the accuracy, speed, and iterations required to solve each problem of five different kinds of state-based search, which includes A* search, Depth-First search, Breadth-First search, Greedy Best -First search, and Dijkstra's Algorithm. Dijkstra's Algorithm was by far the best search for general purposes, being among the fastest, having the lowest costs, and requiring few iterations.



Bradley Canaday Kecoughtan High School Hampton City Schools

Díjkstra's Algoríthm was by far the best search for general purposes

Mobile MINK: Integrating the Mobile and Archived Webs Using Android and Memento

Abstract

Versions of websites specially formatted for mobile devices have steadily increased in number due to the increasing usage of small-screened devices. However, these mobile sites are sparsely represented in web archives when compared to their desktop counterparts. Furthermore, the link between a mobile site and its desktop counterpart is lost in the archives. The Android application Mobile MINK was created to address these issues. It uses the Memento framework to show the complete archival history of a web page across its versions. It also gives users the option of submitting all the versions of a site to various web archiving services, such as the Internet Archive and Archive.is.



Wesley Jordan Menchville High School Newport News Public Schools

⁶⁶the link between a mobile site and its desktop counterpart is lost in the archives

Bradley will attend George Washington University and Wesley will attend Virginia Tech.

Therapeutic Potential of 3-Aminobenzamide and Digitoxin in Lung Cancer Cells and Eugenol in Triple-Negative Breast Cancer Cells



Christia Aspili Kecoughtan High School Hampton City Schools

"My mentorship has definitely been one of the most beneficial learning experiences of my high school career. Being able to apply the things I have learned in my science classes to my lab work was extremely fulfilling and rewarding. Exposure to new laboratory protocols, analysis techniques and cancer biology has helped to shape me as a budding scientist."



Shalni Kumar Poquoson High School Poquoson City Public Schools

"Working in the lab has truly been a one-of-a-kind experience. Not only did I learn valuable techniques, which I hope to use one day as a future researcher, but I also gained a greater appreciation for the patience and hard work behind every discovery, whether promising or not. It was an incredible feeling to carry out successful experiments, independently, and be able to analyze results in such an in-depth manner."

Abstract

Lung cancer is the leading cause of cancer-related deaths in the world. Low survival rates are due to late detection and lack of treatment options, thus new therapeutic methods must be discovered and utilized. The cardiac glycoside digitoxin and the Poly ADP Ribose Polymerase Inhibitor 3-Aminobenzamide have recently been shown to induce anti-tumorigenic effects for in cancer therapy. digitoxin potential use lf and 3-Aminobenzamide are combined, it is possible that their anti-cancer effects can become more effective than if they were used alone. Breast cancer comprises the largest percent of female cancer cases in the US, with triple-negative breast cancer (TNBC) being one of its most aggressive forms. TNBC, characterized by a lack of estrogen, progesterone, and HER2 receptors, tends to form larger, more advanced tumors with higher rates of metastasis. Its corresponding high rate of mortality is in part attributed to the lack of therapeutic choices for this breast cancer type, emphasizing the need to identify novel and effective compounds. Eugenol, a natural derivative of clove oil, has shown promise as a potential treatment for other cancer types, including colon cancer and melanoma. It may thereby function against receptor-negative breast cancers as well.

Human epithelial lung cancer cells (H460) were treated with single and combination treatments of digitoxin and 3-Aminobenzamide. TNBC cells were treated with Eugenol and MTT assay, Hoechst staining, Scratch assay and western blotting procedures were carried out to observe differences in cell viability, apoptosis, metastasis prevention, and protein content respectively. For H460 cells, the combination treatments were less effective in reducing cell viability, inducing apoptosis and preventing metastasis than the solo treatments of 3-Aminobenzamide, but more effective than the solo treatments of digitoxin. Evaluation of protein content showed that both digitoxin and 3-Aminobenzamide upregulated pro-death proteins and downregulated pro-survival proteins of the apoptotic pathway. Single treatments of 3-Aminobenzamide exhibited the strongest anti-tumorigenic. Eugenol significantly reduced cell viability, induced apoptosis, and prevented metastasis in TNBC cells as compared to no treatment groups. Eugenol was also shown to act in a dose-dependent manner; however, the mechanism by which it affects the apoptotic pathway is still unknown.

Christia will be attending the University of Virginia this fall, where she plans to double major in computer science and music. Shalni will pursue a degree in Bioengineering at the Massachusetts Institute of Technology beginning in the fall of 2015, after which she hopes to attend medical school.

Honors Research & Mentorship

























Class of 2015 Achievements

Tidewater Science and Engineering Fair, Old Dominion University, March 2015

The Tidewater Science and Engineering fair (TSEF) encourages middle school and high school students from Hampton Roads to become involved in, and excited about, learning the processes of research and the technical writing skills needed to clearly and effectively communicate the results of their experiments. The Fair provides students the opportunity to exhibit and discuss their projects with judges and evaluators from academia and industry.

Matthew Trepte: 2nd Place Overall Grand Prize; 1st Place Computer Science, *plus* 1 Special Awards (Grafton HS) **Rhiannon Edwards**: 1st Place Award OS Excellence; 1st Place Environmental Science, *plus* 7 Special Awards (Warwick HS) Quintin Lassiter: 2nd Place Award OS Excellence Senior Division; 1st Place Energy & Transportation (Warwick HS) Gabrielle Guill: 1st Place Behavior & Social Sciences, *plus* 1 Special Award (Smithfield HS) **Trevor Powell**: 2nd Place Computer Science, *plus* 2 Special Awards (Denbigh HS) **Kyle Logan:** 2nd Place Mathematical Sciences (Hampton HS) **Robin Bai:** 2nd Place Medicine & Health Sciences (Tabb HS) **Paul Noble**: 3rd Place Computer Science (York HS) John Lee: 3rd Place Electric & Mechanical Engineering (Tabb HS) David Brewster: Honorable Mention Computer Science (York HS) Matthew Vick: Honorable Mention Computer Science (Tabb HS) Sujin Park & Soohyun Yoon: Honorable Mention Biochemistry (Grafton HS) Claire Du & Ji Kim: 2 Special Awards (Grafton HS)





Class of 2015 Achievements

Virginia State Science and Engineering Fair, Virginia Military Institute, March 2015

Approximately 300 students representing 12 regional fairs exhibited their science, technology, engineering and mathematics (STEM) projects this year, with the winners eligible to attend the Intel International Science and Engineering Fair, the world's largest pre-collegiate science competition.

Rhiannon Edwards: 1st Place Environmental Sciences, plus special awards (Warwick HS) **Matthew Trepte:** Leidos Award, 3rd Place Computational Science (Grafton HS)

Intel International Science and Engineering Fair

Matthew Trepte (Grafton, HS)









2015 Virginia Junior Science & Humanities Symposium at James Madison University research presentations. Back Row (left to right): Tim Felbinger, John Lee, Robert Grey, Hoon Ho Shin, Frederick Davis (Sr), Trevor Powell, and Louis Rizzi (Sr). Front Row: Alexandra Kemper, Rhiannon Edwards, Lauren Cook, Laurel Vaughan, and Natalie Ricciardi (Sr).



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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 encourages 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 scientific 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 have included NASA Langley Research Center, Thomas Jefferson National Acceleration Facility, Virginia Institute of Marine Science, Veterans Administration Medical Center, Eastern Virginia Medical School, College of William & Mary, Hampton University, Christopher Newport University, Virginia Living Museum, local engineering firms, hospitals, and a variety of individual medical and professional firms.

