THE GOVERNOR'S SCHOOL
for
SCIENCE AND TECHNOLOGY

Science Research Journal

Spring 2013

Effect of Endocrine Disrupters on Thyroid Hormone Receptor Localization

Abigayle Ceriani
Jamestown High School, Williamsburg/James City County Schools

Shelby Snowden
Jamestown High School, Williamsburg/James City County Schools

"Our mentorship was at the College of William and Mary in collaboration with Dr. Lizabeth Allison. We learned many lab procedures such as how to grow HeLa cells in culture. We also had the opportunity to listen to science seminars held at the College of William and Mary. Our mentorship experiences and the knowledge that we gained will prepare us for college and future research experiences."

Abigayle will be attending the University of Virginia this fall, majoring in biology.

Shelby will be attending James Madison University this fall and will also be majoring in biology.

Abstract

Thyroid hormone is critical in human development and homeostasis. Thyroid hormone binds to thyroid hormone receptor (TR) allowing gene transcription to occur. Bisphenol A (BPA) is an environmental chemical commonly found in plastics such as water bottles. BPA is thought to act as an antagonist to TR, binding to it, but not activating it and preventing gene transcription. BDE-100, a brominated flame retardant, is often found in electronic equipment, plastics, paints, construction materials, and synthetic textiles. BDE-100 is thought to disrupt the function of thyroid hormone by binding to chemicals which are necessary for thyroid hormone production and inhibiting them from performing their usual function.

Human cells grown in culture were exposed to BPA and BDE-100 to determine their effect on the localization of TR in the cells. The cells were transfected with green fluorescent protein in order to view the location of TR within the cell using a fluorescence microscope. In cells treated with BPA and BDE-100, TR seemed to shift from being present mainly in the nucleus, as is normal, to being present in both the nucleus and the cytoplasm of a cell. However, using an ANOVA test and a student's t-test, null hypotheses of no differences among treatments could not be rejected. More replications are needed with less within-treatment variation to determine if exposure to BPA and BDE-100 disrupts the activity of TR, making these chemicals dangerous to exposed organisms.

> *"Thyroid hormone function may be disrupted by environmental chemicals"*

Neutron/Gamma Pulse Shape Discrimination with Flash ADCs

Abstract

Uncharged particles are relatively difficult to identify when compared to charged particles because they lack the field that can be detected with charged particles. To solve this problem, researchers use a technique called pulse shape discrimination to distinguish one uncharged particle type from another. This process involves comparing the pulse shapes of the uncharged neutrons and gammas that pass through the detector. Identification can be made because a neutron has greater energy in the tail of its pulse, while the gamma has greater energy in the peak of its pulse. This process is well established, but limited by the speed of the identification by the analog–to–digital converters used currently. Newer, flash analog–to–digital converters have capabilities to perform this process at greater speeds.

The new flash analog-to-digital converters (FADC) were run in the same setup as the old analog-to-digital converter (ADC). The FADC was found to be consistent with the ADC system. Also, the trigger circuitry required for the FADC system was found to be much simpler than the comparable circuit for the ADC system. The zero energy level for the FADC system can be computed dynamically, resulting in the possibility that the FADC system could provide more accurate data, even with the presence of background noise.

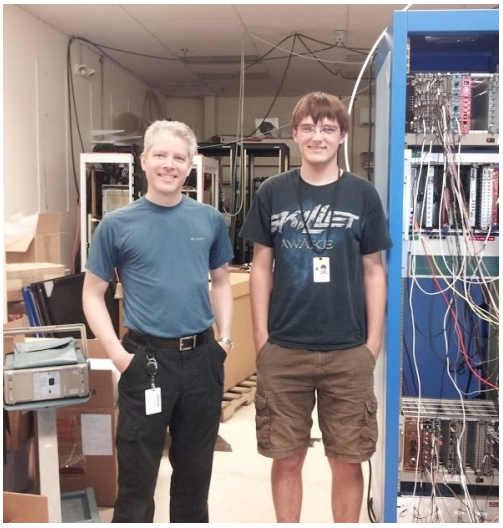
"Pulse shape discrimination is used to distinguish uncharged particles types"

Charles Dauchess

Jamestown High School, Williamsburg/James City County Schools

"This year I had the wonderful opportunity to do my mentorship with Dr. Brad Sawatzky at Thomas Jefferson National Lab. I learned many new things that are beyond the normal high school curriculum, from basic computer programming to setting up and troubleshooting data acquisition systems. This experience has also influenced my degree choice, causing me to lean slightly towards electrical engineering over mechanical. I looked forward to my time at Jefferson Lab every week and found this experience incredibly rewarding."

Charles will be attending Virginia Tech this fall to pursue a degree in mechanical or electrical engineering.



Emergency Physician Interruptions

Samantha Giaccio
Poquoson High School, Poquoson City Schools

"This year, I had the opportunity to shadow Dr. Garrison, an emergency physician at Sentara CarePlex Hospital. I enjoyed my mentorship experience because I was able to witness a variety of patients and cases, and interact with other hospital staff. Dr. Garrison taught me various medical terms and procedures, including how to read CAT scans and X-rays. I witnessed the teamwork that is required in an emergency department, as well as the importance of an emergency physician being broadly trained because of the varying nature of his patients. It was also great to have the opportunity to speak with other staff members, including undergraduates who are hired as scribes for the physicians and plan on going to medical school. This mentorship was perfect for me and I'm thankful for the Governor's School for the opportunity to have this experience. I hope to attend medical school in the future and to expand upon what Dr. Garrison has taught me."

Samantha will be attending the University of South Carolina to study Biochemistry and Molecular Biology. After undergraduate studies, she hopes to attend medical school to pursue a career as a physician. While at USC, Samantha plans to continue work in a local hospital or clinic.

Abstract

Multi-tasking has become a huge part of today's society despite the risks involved. Many studies have been conducted to identify the risks and to initiate measures to reduce multi-tasking in high-risk occupations. Unfortunately, no measures have been initiated to reduce the process of multi-tasking for emergency physicians, a very high-risk occupation. Emergency physicians are constantly being interrupted by their coworkers and patients, especially since their work is centered in the middle of a necessarily chaotic emergency department. Interrupting an already busy physician increases the chance of errors, which may negatively affect patient care. Errors can be minor, but a steady pattern of errors can build and result in serious problems such as misdiagnosis. An extended observational study was conducted to determine how many times a physician in this field is interrupted during an average shift, the sources of these interruptions, and how interruptions impacted the physician directly. The hours for data collection varied, due to the varying nature of the emergency physician's schedule, but not all shifts were covered for data collection due to restrictions of the observer. The study suggests that most of the physician interruptions were by nurses. An increase in interruptions negatively correlated with patient throughput. The data supports initiating measures for reducing interruptions by either changing the physical layout of an emergency room or creating policies to allow physicians to focus on their tasks.

"identify risks and initiate measures to reduce multi-tasking in high-risk occupations"

Finding the Strain-Optic Coefficient of Fused Silica: 3D Residual Stress

> *"Spacecraft windows may fail due to stress resulting in loss of life and vehicle"*

Abstract

Spacecraft windows are subjected to stresses that may result from the manufacturing of the glass, installation, impacts from space debris, and re-entry into the atmosphere. These stresses can cause the window to fail, resulting in loss of life and vehicle damage. A procedure was developed for creating quantitative residual stress images in laboratory-impacted fused silica (shuttle glass) specimens. In order to calculate the residual stress, the stress-optic coefficient (K) of fused silica was determined. This was done by loading various fused silica specimens in four-point bending and measuring the magnitude of the optical retardation at a series of locations across the specimen with a commercially available gray-field polariscope. Using the governing equation, the stress-optic coefficient was determined. Acrylic was used to validate the method performed because its K is already available in scientific literature. The experimentally determined value of K for acrylic was found to be within 6% of the literature value and within one standard deviation of the measurement, validating this procedure for experimentally determining K. Using the same method, the K for fused silica was then determined and applied to the laboratory-impacted fused silica specimens. The stress images created will be applicable to construction, maintenance, and replacement of spacecraft windshields.

Maurice Hayward
Warwick High School , Newport News City Schools

"Governor's School has been a wonderful, but challenging experience for me. The highlight of our time at Governor's School is our senior mentorship project. I had the awesome privilege of working with Mr. Elliott Cramer, the branch head of the NASA Nondestructive Evaluation Sciences Branch. I learned a lot of information at Governor's School which I thought I might never use; but everything I learned was applied in my mentorship in one way or another. I gained confidence in my own ability and appreciation for what I've learned at Gov School."

Maurice will be attending the College of William & Mary, where he plans to double major in computer science and mathematics.

Quadcopter: Design, Build and Test

Jennifer Pandolf
York High School, York County Public Schools

Zachary Rosen
Smithfield High School, Isle of Wight Public Schools

"Having the opportunity to go through the design and fabrication process during this mentorship was absolutely phenomenal. In college, I will continue to use the principles of engineering that I have learned. After graduation, I plan to join the Peace Corp and to work with governmental and private organizations to use engineering to help citizens of developing world countries. Knowledge is power, and that power is most effectively used when helping the billions of disadvantaged people around the world. " ZR

Jennifer will attend Virginia Tech to study engineering.

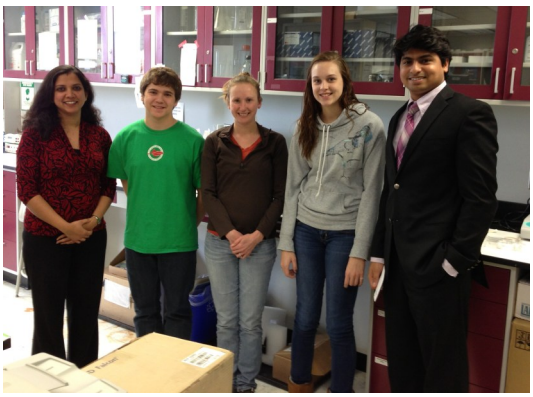
Zachary will attend the University of Virginia to study mechanical engineering.

Abstract

Many current search-and-rescue (SAR) tactics lack effectiveness and are not time-efficient. Quadcopters, a very new, yet booming, remote control niche, may be able to find missing people more efficiently than current SAR methods. These unmanned aerial vehicles usually have a diameter of three feet and run using four propellers paired with four standard remote-control plane motors and a mother board. Due to the programming diversity of these crafts and their relatively low cost, quadcopters are being used in every way possible by developers all over the world. While many scientists use these capable vehicles merely for parlor tricks, this project was aimed at using their low flying abilities and their stability to allow a camera to be mounted and used for search and rescue. A quadcopter will fly a pattern over a ball at different heights and speeds. The intent of the study was to prove the feasibility of quadcopters in SAR, and to test the limits of speed and altitude during SAR. These two parameters are very important, the more speed and altitude that can be used, while still preserving visual clarity, the more efficient the SAR. If the quadcopter could accomplish this and at the same time work more quickly than the typical human, this would be a breakthrough in search and rescue and could save low flying abilities and their stableness to mount a camera and use them for search and rescue.

"Quadcopters may be able to find missing people more efficiently than current search and rescue methods"

Treatment of Human Bronchial Epithelial and Lung Cancer Cells with Resveratrol



Abstract

Lung cancer is among the deadliest forms of cancer primarily due to the lack of treatment options available. Recently, the natural molecule resveratrol has shown promise in being an effective anti-cancer agent. Resveratrol can be found in natural abundance in plants and is popularly known for its presence in red wine. Unfortunately, little is known about resveratrol, and its anti-cancer characteristic has not been confirmed. A wide variety of biological analyses were conducted to study the effects of resveratrol at various concentrations using human bronchial epithelial cells (Beas-2B) and lung cancer cells (H460).

Treated cells were tested for effects, such as an increase in reactive oxidative stress, which is thought to cause induction of apoptosis, programmed cell death. Resveratrol induced apoptosis in the H460 cells. Similarly, the cells were tested for their emission of vascular endothelial growth factor (VEGF). The emission of VEGF encourages the formation of blood vessels in and around the cells so they may grow and reproduce. Resveratrol reduced the emission of VEGF from the H460 cells so that they could not receive blood, and were unable to function. Western blot and mRNA analysis were conducted to analyze various regulatory proteins that induce or reduce apoptosis. The proteins that induced apoptosis were increased in the H460 cells in direct relation with resveratrol. These biological analyses confirmed that resveratrol has strong anti-lung cancer characteristics, while still allowing the non-tumorigenic cells to function properly.

> *"the natural molecule resveratrol has shown promise as an effective anti-cancer agent"*

Aubrey Brockmiller
York High School, York County School Division

"Upon first meeting Dr. Neelam Azad and touring the facility at Hampton University School of Pharmacy, I was nervous about working in the lab because I feared I would mess up the entire experiment. But I owe a huge thank you to Dr. Elizabeth Monillas who worked with me every step of the way and eased any nerves I had. Working in the lab gave me a new understanding for the world of research, taught me patience and flexibility, and gave me the skills I will need for college and medical school. This mentorship was a valuable experience that I will always remember because it gave me the confidence to pursue a career in medicine."

Aubrey will pursue a degree in Biochemistry and Molecular Biology at the University of South Carolina beginning in the fall of 2013, where she will continue to do research.

Grayson Walker
Poquoson High School, Poquoson City Public Schools

"My mentorship got me excited about scientific research, inspiring me to get involved with research while in college and possibly even beyond that. I would like to thank Dr. Anad Iyer for giving me access to the lab and Dr. Elizabeth Monillas for working directly with me and teaching me all I needed to know about the research."

Grayson will pursue a degree in engineering and pre-med at the University of Virginia beginning in the fall of 2013 and hopes to apply to the biomedical engineering program.

Comparison of Propulsion Methods

> *"LENR is capable of producing large amounts of energy and could power a rocket"*

Abstract

The United States has been researching and sending rockets into space since the 1950s, the start of the Space Race. Chemical propulsion has been used to power these rockets since the beginning of space exploration. However, chemical propulsion is nearing its maximum efficiency and continues to have a high cost, so a new method is necessary for the future of space exploration. Nuclear thermal propulsion is the most likely successor, providing for faster travel and higher payload mass; but it is limited by the added mass of a radiation shield and the lengthy process and expensive facilities required for testing. A new technology, Low Energy Nuclear Reactions (LENR), formerly know as cold fusion, is capable of producing large amounts of energy without producing radiation, and could power a rocket.

Optimal values of specific impulse, change in velocity, and initial mass were determined for several future missions. The actual values of the variables for the propulsion methods for each mission were compared to the optimal values, as demonstrated in the work of Osenar and Lawrence; but LENR lacked enough specifications for an accurate comparison in this process. LENR was then compared with nuclear thermal propulsion over these same proposed missions in order to determine at which size mission LENR would offer the best improvements. It was determined that LENR was most effective when the shielding-to-final mass percentage was at its greatest enabling the mission to have more payload, fuel, or weigh less.

Jason Akers
Poquoson High School, Poquoson City Schools

"My mentorship was a truly exceptional experience. In the beginning, I had almost no clue what I wanted to major in in college, wavering among numerous types of engineering, nor any clue about what mentorship project that I wanted to work on. My mentor not only explained Low Energy Nuclear Reactions and how this process will be the energy source of the future, but more importantly, that the person who could create the technology would be the next Bill Gates. This project fit me perfectly; not only did it grab my attention with the LENR, but it also allowed me to experience the different types of engineering to better help me chose a major. The mentorship itself was fun, as I was able to learn about all of the different types of rocket propulsion, the process of designing a mission from scratch, and about technologies that could be the wave of the future. My Governor's School and mentorship experiences have prepared me to pursue future research opportunities and enhanced my resume so that I could attend one of the best universities in the world."

Jason will attend the Pratt School of Engineering at Duke University in the fall to pursue a major in mechanical engineering with an aerospace engineering certificate. He hopes to continue working with NASA in the future.

Assessing a Model for Simulating Response of Aluminum Honeycomb Core to Transverse Loading

> *The 1-dimensional material model is a highly accurate method of predicting core response.*

Abstract

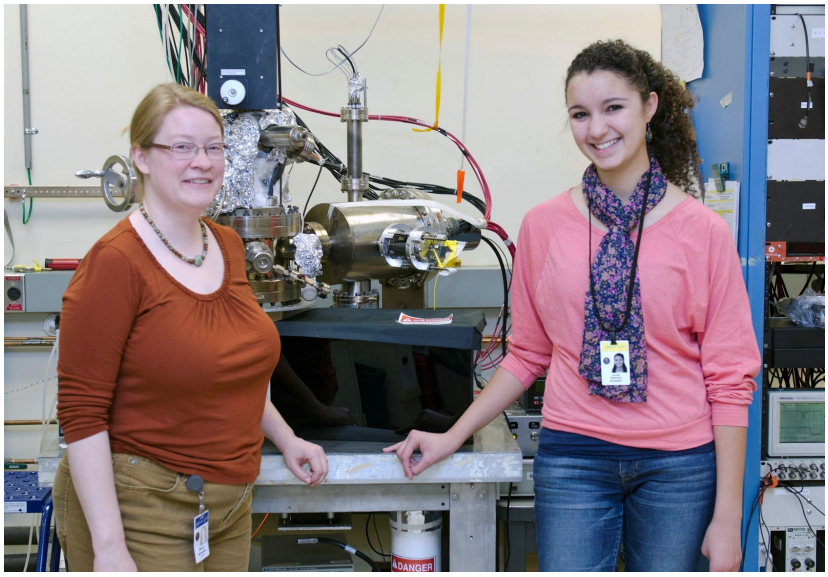
In weight-critical applications such as airplanes, honeycomb sandwich structure made of composite materials has been suggested as an effective alternative to heavier metals due its lower density and thus lighter weight but retained transverse stiffness. However, transverse loading on the honeycomb structure can cause a buckled core, resulting in greatly reduced resistance to further loading, yet without a noticeable dent in the outside facesheet. Predicting the damage caused by transverse loading is very important in order to assess core damage if the facesheet shows no outward sign of damage. The predicting method must be accurate, yet not be computationally intensive or require excessive input. The 1-dimensional material model method involves treating the honeycomb core as trusses, and is proposed as a quick yet accurate predicting method. The accuracy of this method was tested by comparing model simulation results with real-life beam core compression (BCC) tests on the honeycomb structure. Global specimen response, residual dent geometry, and amount of core crush results of the simulation compared with those of the BCC test suggest that the 1-dimensional material model is a highly accurate and quick method of predicting core response.

Conner Silveria
Tabb High School, York County Public Schools

"Math and physics have always been a passion for me, so applying those topics through mechanical and materials engineering was a great way to experience a research culture. My mentorship topic furthered my interest in those areas, and also sparked an interest in computer programming, part of the simulation process. Working at NASA Langley Research Center allowed me to see first-hand what research life was like, and gave me tools and insight that will progress my education and career in engineering. I am very thankful for my mentor for introducing me to many aspects of his work and assisting me throughout much of the mentorship. The Governor's School allowed me to reach my goal of attending at top-rated university and further my interest in math and science."

Conner will attend Duke University in the fall of 2013 on a Navy ROTC scholarship and plans to earn a degree in mechanical engineering.

Optimization of a Micro-Mott Polarimeter for Gallium Arsenide Photocathode Analysis and Increased Electron Source Polarization



Lauren Chambers
Kecoughtan High School, Hampton City Public Schools

"My mentorship with Dr. Marcy Stutzman has unquestionably been the most beneficial experience of my life. Not only have I developed specific skills with respect to programming, laser optics, and high voltage systems; but I have also developed general skills such as thoroughness, focus, and patience that I will carry through life. My mentorship has exposed me to different aspects of the worlds of professional scientific research, engineering, and applied programming, thus allowing me to explore the idea of a career in nuclear physics before even entering college. I greatly enjoyed the nine months I spent working with Dr. Stutzman at Jefferson Lab, and I am deeply thankful for the unique opportunity provided by the Governor's School for Science and Technology."

Lauren will be attending Yale University in the fall and plans to pursue a major in astrophysics with a minor in Spanish or Latin American Studies.

Abstract

Demand for improved electron beam polarization is growing in scientific communities worldwide; superlattice strained gallium arsenide (GaAs) photocathodes are used universally as polarized electron sources. The micro-Mott electron polarimeter at Thomas Jefferson National Accelerator Facility is used to evaluate gallium arsenide photocathodes for use in the Continuous Electron Beam Accelerator Facility on-site. After activation with nitrogen trifluoride and cesium, GaAs crystals emit polarized electrons when exposed to circularly-polarized infrared laser light. Using electrostatic lenses, the resultant electrons are steered into a gold target where the electron beam bounces off the target in two directions; the number of electrons that continue in either direction is proportional to the degree of polarization of the electron beam. This micro-Mott system has been renovated with a tunable Ti-Sapphire laser and a computerized lens steering system, and streamlined software has been written to improve accuracy, precision, and autonomy. A novel gallium arsenide-antimony (GaAs-Sb) photocathode has been tested and compared with the standard GaAs superlattice cathode, as it was expected to produce higher polarization and be more durable, extending operational lifetime. However, it has consistently returned unusably low quantum efficiency, despite stably high polarization. Adjusting growth parameters for higher yield may reveal higher quantum efficiency levels.

> *"Micro-Mott system has been renovated to improve accuracy, precision, and autonomy"*

Oyster Reef Restoration and its Effects on Reef Community Structure

> *Restoration projects rehabilitate oyster reef communities.*

Abstract

In the 19th century, oyster reefs were abundant across the Chesapeake Bay. Oyster fisheries in Virginia and Maryland represented 59% of the total fisheries in the United States. The number of reefs declined significantly around the 1940s due to overfishing, disease, and habitat destruction. In addition to oysters, bivalves, crustaceans, and fish rely on the reefs for survival. Restoration projects are in effect to help restore and rehabilitate the reef community. Samples from six reefs at each of four locations were collected from reefs constructed according to tidal flow. Each bivalve, crustacean, and fish collected was identified, counted, and dry massed and ash-free dry massed to determine biomass. Two-way ANOVAs showed that the locations of the reefs were significant in abundance and biomass values. Further statistical analysis, including non-parametric multi-dimensional scaling, analysis of similarity, and SIMPER tests supported the change in abundance and biomass between locations.

Hannah Cagle
Gloucester High School, Gloucester County School Division

"Throughout the year I had the opportunity to work with Allison Colden at the Virginia Institute of Marine Science. The mentorship experience was both challenging and exciting. Learning how to correctly identify organisms and collecting data for analysis was a challenge at first. As I progressed into the project, my lab work became exciting as results started to come in. The mentorship project helped me develop skills that I can use in college and beyond. This year-long project matches students with scientists whose fields of work interest the students. Students are able to conduct more in-depth and higher research prior to their undergraduate studies. I can not think of a better way to learn the research skills needed for college studies and research than the mentorship experience during senior year."

Hannah will be attending Washington College this fall, majoring in Biology.

Analyzing Warrick and Brass's Performance on Gil

Abstract

Warrick is a program that attempts to recover a website by scouring web archives such as Internet Archive and Google for cached copies of web pages, an activity known as lazy preservation. It has been running and accepting public jobs for around half a decade, but the last analysis of the website archives it uses took place in 2009, with a very small sample size. Gil is a program that was written to take the thousands of website recovery jobs from Warrick's server and analyze successes based on which web archive the files were successfully recovered from, when they were recovered, and what kind of file they were. This data showed that the Internet Archive was the most reliable archive, and the rate of its success in web page recovery was three to one. However, due to archive caching practices, an increasing use of client side scripts, and a move towards web 2.0, the websites recovered with Warrick might not be usable in the state that the archives can capture.

> *"Success of web page recovery was three to one."*

John Herman
Jamestown High School, Williamsburg James City County Schools

"For my mentorship I worked with Mr. Justin Brunelle at MITRE corporation. He supervised me in the creation of a computer program named Gil, a program that collects data on the performance of Warrick and Brass. Warrick and Brass are programs that crawl web repositories, archives like the Internet Archive and WebCite; and Gil provides user and operator feedback on the success rates. My mentorship has taught me new programming languages and skills, and how a computer science work environment should be like (I can only hope other locations are as pleasant to work in). If I hadn't already been sure that computer science would be my major, my mentorship with Mr. Brunelle at MITRE would have made me sure."

John will attend the University of Virginia in the fall to pursue a major in computer science.

Cloning of the Gene rv0894 From Mycobacterium tuberculosis

> *"RV0894 is a possible drug target or marker for dormant organisms in humans."*

Abstract

There is currently no known cure for tuberculosis. The genome of the best-characterized strain of *Mycobacterium tuberculosis*, H37Rv, has been completely sequenced containing over 4 million base pairs and 4,000 genes. Gene *rv0894* produces a protein that has no known function but is thought to be a transcriptional regulator. The protein product, RV0894, is necessary for the survival of the bacteria and must be present in order for the bacteria to grow and reproduce. The gene *rv0894* was cloned into a bacterial expression vector, pET 28a, which produced a large quantity of the purified protein, which then underwent further biochemical studies. After digestion of the purified vector, the linear fragment contained 5329 base pairs, which confirmed that the 1400 base pair gene fragment was successfully cloned into the vector.

It is possible that the RV0894 protein binds to metals like iron because of a high concentration of amino acids that are commonly associated with metal binding proteins. It is also hypothesized that RV0894 has enzymatic activity because it contains a P-loop and because of its close resemblance to protein 1Z6T, which binds to ADP. Because RV0894 is necessary for survival of the bacteria, it has been listed as a possible drug target and a possible marker for locating the organism inside humans when it is in the dormant phase, an occurrence which there is currently no test. Finding the specific functions of RV0894 could lead to finding ways to inhibit its expression, or the protein itself, which could be used to shut down the survival of the cell and therefore kill the bacteria.

Taylor Ferguson
Windsor High School , Isle of Wight County Public Schools

The first several days of mentorship were somewhat intimidating and the learning curve was steep. My mentor was very encouraging and supportive. Mentorship was a terrific experience and has given me confidence to challenge myself as I move into college and later into a career (Modified from conversations with TF by M. Mulvey).

Taylor will be attending the College of William & Mary in the fall to study biology.

Assembly of a Heliocopter-Based Test Article for Development of the Heliogyro Solar Sail

Abstract

Modern spacecraft are limited in their range of travel by their finite capacity to carry fuel for propulsion. Regardless of the method by which they turn propellant into energy, they will eventually run out of fuel. By utilizing solar pressure as a means of propulsion, solar sails have the potential to be a near-perpetual energy source. A solar sail is a thin membrane that absorbs solar radiation and turns it into momentum to accelerate the spacecraft. With a large sail surface area, the resulting acceleration could provide enough propulsion to move a spacecraft at speeds practical for space exploration. Because of the perpetual nature of this acceleration, the spacecraft could actively operate for years.

Solar sails are often constructed from a thin, lightweight membrane. The membrane is inherently flexible, and so all spacecraft utilizing solar sails need some method of deploying and then stiffening the sail. In the 1960s, the heliogyro design was proposed to meet this requirement. In a heliogyro design, blades of solar sail material attach to a central hub. By spinning, the heliogyro uses centripetal force to keep the sail taut. However, undesirable movement is still present in the blades. This movement needs to be understood and actively controlled. To facilitate this, a test article, based on a remote-control helicopter, was built to mimic and record the blade movement in a vacuum chamber. With photogrammetry software, video data from the onboard cameras will be used to measure the motion of the blades, which will be useful in developing an analytical model.

Thomas Cleckner

Hampton High School, Hampton City Public Schools

"I have always enjoyed problem-solving and learning how things work, which are two things I believe are at the heart of engineering. I had the opportunity to do both with my mentorship work, an opportunity for which I am extremely grateful. The rather wide latitude I was given in approaching the problem of designing and integrating the sub-systems of the test article was overwhelming on occasion, but made it all the more satisfying when my project came to a successful close. The experience I gained in the trouble-shooting process is invaluable, and I am happy to have had the peripheral exposure to the subject areas of material properties and photogrammetry, areas I hope to learn more about in the future."

Thomas will be attending Virginia Tech in the fall and plans to pursue a major in engineering.

> *"Solar sails have a near perpetual energy source"*

Costa Rica
Field Research Experience

Governor's School students visited research and educational facilities in Costa Rica during the week of Spring Break. At an organic farm near Arenal, students prepared a field and applied organic fertilizer (top picture). The farm is used to demonstrate organic methods to local farmers and to encourage application of sustainable agricultural practices. At the Organization of Tropical Studies La Selva Research Station, students experienced tropical ecosystems and biodiversity (bottom left picture). Students also hiked along lava flows at the Arenal Volcano (bottom right picture).

THE GOVERNOR'S SCHOOL
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Honors Research and Mentorship Program

A primary goal of the Governor's School for Science and Technology (GSST) is to provide students with an opportunity to conduct serious scientific research. 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 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. In addition to their outside mentor, a faculty advisor is available to assist and evaluate mentorship research.

Major aspects of the mentorship experience include preparation of a formal written proposal for their project, oral presentation of the proposal and mid-year status report to GSST faculty and evaluators, a final research document, and presentation of final results to a panel of outside 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 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.

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