

Delaware Valley Science Fairs

MEET THE MEDALISTS 2019

Vignettes and Project Abstracts of DVSF Medal Winners in 9th through 12th Grades

Compiled by Sheila Romine Director of Mentorship and Communications Delaware Valley Science Fairs





Below are vignettes of the medalists from the 2019 Delaware Valley Science Fairs. The medalists won all-expense-paid trips to compete in the Intel International Science and Engineering Fair (ISEF) in Pittsburgh, Pennsylvania.

12th Grade Fair



MEET THE 2019 DVSF GRADE 12 GOLD MEDALIST—Amanda Shayna Ahteck, Holmdel High School, Holmdel, New Jersey. She developed "A Novel Low Cost Resistive Soft Crochet Stretch Sensor as Applied to a Wearable Bluetooth Keyboard Text Input Device--midiKEY." Shayna was a 2019 Regeneron Science Talent Search (STS) Semifinalist.

Shayna talks about her project:

Most people think that research gets started in a lab under controlled conditions. My project started as I was crocheting under my desk in my first-year physics class. (I know I probably should have been paying more attention to my teacher, so don't say I told you not to pay attention in class!) But while he was explaining the resistance and resistivity formulas, I was connecting to the crochet in my hands. I could see how a wire with the geometry of a chain stitch would stretch when pulled, decreasing its thickness, increasing its length, and changing the resistance. So, I thought, why don't we have stretchy wires like this? I borrowed a spool of conductive thread from my

school's MakerSpace, crocheted it with the tiniest hook I could find (2 mm), and used a multimeter to test the resistance drops when stretched.

By questioning the resistivity formula and a little bit of insight from my crocheting hobby, I invented a new kind of soft stretch sensor.

To apply my sensors, I thought of the character Sombra from the video game Overwatch. One of her main abilities is "hacking" by typing in the air. I started looking up projects other people had done sewing microcontrollers and sensors to gloves to make a gesture-based keyboard. But I knew, as someone who rang handbells, that gloves get very sweaty and are impractical for real life. I sought to make a jewelrybased device that mimicked the tendons in your hands. Inspired by the fashion trend of midi rings at the second knuckle, I used them in my device along with a watch-like microcontroller and called it the midiKEY.

I worked in my room and my kitchen over the summer, somewhat far removed from a real science lab. My parents looked on in confusion, but I loved taking my work home with me and taking personal time I took into building and documenting the creation of the midiKEY. I'm very excited to represent Holmdel High School at the Intel International Science and Engineering Fair, as the first ever Finalist from my school.



MEET THE 2019 DVSF GRADE 12 SILVER MEDALIST—Isha Mohapatra, Moravian Academy, Bethlehem, Pennsylvania. She researched "Heat Loss Through a Wall Made with Optimized Insulating Bricks."

Isha describes, in her own words, the motivation for her research project:

It's 2 AM and pitch black outside — a time I have been awake at far too often. The yellow light of my basement seems to dull with each hour making my eyes feel heavy.

My arms are sore from kneading the clay and sand together and I just want to stop and go to my bed. I look down at mixture of clay and sand, *Now I only have to put this into molds and lay the bricks out to dry aaaand repeat,* I think to myself. My clock now says 2:15 AM — I knew I wasn't going to bed until 4:00 AM at this point. Why didn't I just stop? Did I really find bricks that interesting? Was something seriously wrong with me for having so much drive for ceramic construction material? Sleeping would be so much easier in this moment, but something kept me from being able to stop. I had a goal in mind and I had to complete it. Two years had already gone by since I first conceived the idea of an insulating brick, but here I still was, mixing and molding the bricks because I had to make them strong enough for construction. I was so far in, that I couldn't back out. I knew I would regret leaving my project as it was because I was working towards something that could quite possibly be a solution to our environmental problems — something that could allow future generations to live in a clean world.



MEET THE 2019 DVSF GRADE 12 BRONZE MEDALIST—Claudia Schreier, Marine Academy of Technology & Evironmental Science, Stafford Township, New Jersey. She researched "Algal Fertilizer: Enhancing American Beachgrass Growth on Dunes."

Claudia shares about her research experience:

When I was in 10th grade, my Aquatic Ecology class went on a field trip to my county's wastewater treatment plant, and I learned the facility creates a fertilizer

from the treated waste. The fertilizer includes heavy metals, pharmaceuticals, and whatever else could not be filtered out during the waste treatment process. In addition, I found that the fertilizer was being used at my local beach! Although the fertilizer is used to help dune grass thrive in the harsh coastal environment and protect our coastline, the excess nutrients and chemicals provided by the fertilizer flow through sand quickly, potentially harming marine life. To address this concern, I created an all-natural, slow-release, solid fertilizer from algae that is both environmentally friendly and economically viable. This research involved long hours wading through the bay in order to harvest algae, and then cooking and dehydrating the algae in my kitchen. As a result of my research, I demonstrated the success of my algal fertilizer by measuring dune grass health. However, I may never be able to eat seaweed salad ever again!

11th Grade Fair



MEET THE 2019 DVSF GRADE 11 GOLD MEDALIST—Neil Deshmukh, Moravian Academy, Bethlehem, Pennsylvania. He researched "An Adaptive, Low-Cost Device for Automated & Offline Medical Analysis Utilizing Neural Networks with Reinforcement Learning Optimization." Neil will be attending ISEF for the 2nd time. He represented DVSF at Intel ISEF 2017, and received a 2nd Place Award.

Neil describes his motivation here:

In 6th grade, I discovered superpowers were real.

And they were fueled by technology. I could give life to plastic and metal, with robots. I could shape entire worlds and rewrite reality, through code. With the onset of Artificial Intelligence (AI) technology, I created programs to detect plant diseases, and help blind people 'see' again by describing their environment. I developed

applications that could look into the future and predict trends, biophysical and economic. We now have algorithms that can do what we once only thought humans could do. Sometimes the algorithms are even better than humans.

Although it has not yet been tested on human participants, my science project this year is essentially an AI doctor that can conduct a 5-minute, private, preliminary medical analysis, right in your home with an accuracy comparable to medical personnel; it can recognize skin afflictions, detect cardiac anomalies, and identify biomarkers of cognitive decline; it also helps alert medical professionals if there are any medical conditions present by processing symptoms. I was inspired to undertake this project after seeing the sparsity of healthcare in less-fortunate areas, and I hope that my project will be able to identify high-risk patients, helping people get treatment, and eventually, saving lives.



MEET THE 2019 DVSF GRADE 11 SILVER MEDALIST—Zoe Frantz, Avon Grove High School, West Grove, Pennsylvania. She researched "Testing of the Future."

Zoe explains her project here:

My project, "Testing of the Future" questions if students should be taking their statemandated standardized tests online or on paper. This project resulted from my school's choice to give each student a laptop, and with this, switch to have all state standardized testing be taken online. I chose to conduct this experiment because many of my classmates were hesitant about using laptops for class, especially with the testing being online. I wondered if the hesitation resulted from a fear of test scores dropping due to a change in method. I was able to discover that scores are dropping in fact from a change from paper testing to online testing-but only for high school students. For students that have only taken their standardized tests on paper, their scores are higher when tests are taken on paper. But for students in elementary school, the method the student takes the test does not affect the score, because the students are more comfortable with taking tests both on paper and online.



MEET THE 2019 DVSF GRADE 11 BRONZE MEDALIST—Caden Traversari, Springside Chestnut Hill Academy, Philadelphia, Pennsylvania. She researched "The Effect of Endocytosis Altering Substances on Vacuole Formation in Tetrahymena."

Here is Caden's story about how she got her idea:

I started the project that eventually became my official project, titled The Effect of Endocytosis Altering Substances on Vacuole Formation in Tetrahymena, in November of this school year; however, the idea I started with in November is related to the project it became only in the most attenuated, winding road kind of way. As surprising as it may sound, I did not wake up one day and say "I want to study the effects of endocytosis altering substance on vacuole formation in Tetrahymena!" Actually, at the time I had no idea what Tetrahymena were, and only a very basic understanding of vacuoles and the role of endocytosis in vacuole formation. What actually set me on path to this project was researching statins. I had recently been diagnosed with hypercholesterolemia caused by a genetic mutation, and in the course of discussing treatment with my doctors started to learn about statins and the mechanism of action. My reading about statins included information about side effects, including

references to the impact of certain citrus fruits on the metabolization of statins. It so happened that my reading happened to coincide with an assignment in biology class to identify an experiment for entry into a local science fair. I started to think of experiments relating to the rate of metabolization of statins, but there were few hurdles to this kind of work in a high school lab (namely, humans and blood). I stayed with the idea of statins and side effects, and found a reference to the impact of statins on endocytosis in the aquaporin-2 water channel (AQP2) kidney transporter. This reference was the start of my idea — did statins affect endocytosis in other areas. However, I had no idea how to test this. I obviously couldn't feed prescription drugs to my highschool peers, and even if I could, I didn't know how I could even tell if it did affect areas of endocytosis. So, I started looking at what endocytosis plays a role in. Thankfully, when my first google page came up empty, and the second, and the third, I kept going to the fourth, where I learned that vacuole formation in Tetrahymena depend on endocytosis. Bingo! From there I learned more about Tetrahymena, vacuoles, and vacuole formation in Tetrahymena and was able to move from my basic idea to an experimental design:. I was going to introduce statins to Tetrahymena, feed them (which is when endocytosis is involved), then observe vacuole formation and compare it to that of Tetrahymena not introduced to statins. However, I wanted one more variable, and so when I found that Dimethyl Sulfoxide was known to affect endocytosis only in the GLUT4 glucose transporter, I quickly added it to my experimental plan. By January I had spent many sessions after school collecting data in one of my school's science lab, and had finished my experiment. While all aspects of my project were done independently, I owe a huge thank you to Mr. Stein, head of the science department at SCH and my honors biology teacher, as he helped to procure all the materials I needed and supported me every step of the way.

10th Grade Fair



MEET THE 2019 DVSF GRADE 10 GOLD MEDALIST—Prathysha Kothare, Parkland High School, Allentown, Pennsylvania. She researched "Re-envisioning Erythrocyte Dynamics: Computational vs. Experimental Modeling of RBC in Capillary Shearing." She also represented DVSF at ISEF last year and placed 3rd in the Biomedical Engineering category!

Prathysha's story:

Around ten years ago, watching Spongebob and frolicking in ballet tutus were the center of my life. At that time, my understanding of engineering, biology, and computer science was limited to a romantic fascination with their applications, but I was far from truly knowing what these fields were about. Indeed, prosthetics were like sci-fi realities come to life, my sole purpose for computers was to exploit the wonders of CoolMath and Webkins, and engineering was a fancy word I could throw around to sound smart :) It wasn't until I started going to science summer camps, where I built catapults, learned simple electricity by building circuits, and mixed chemicals to learn about exothermic reactions, that I realized how versatile and insanely thrilling STEMM could be. Through these seemingly simple activities, my mindset of merely asking "what" quickly transitioned to a rabid desire to understand HOW! I finally found myself chiming in at dinner-table discussions during which my chemical engineer parents often rambled about obscure but intriguing concepts of "process system controls" and "fluid dynamics." After sitting in on my father's university lectures and finding out that both my mother and father had written over 200 pages worth of PhD dissertations (I still can't wrap my head around that!), my yearning to become part of the STEMM community truly blossomed. Since seventh grade, I have been pursuing scientific research and don't plan on stopping anytime soon!

For my research this year, I wanted to explore the mechanical properties of red blood cells. We are probably all familiar with heart pumps and diseases like sickle cell and anemia, but if someone asked us to explain how red blood cells behave molecularly during circulation in each of these situations, we'd probably scratch our heads. Thus, I sought to study how these cells and their molecular structures respond to different blood flow conditions. I went about accomplishing this goal using computer models combined with laboratory studies. The long-term goal of this research is to publish a simple mathematical model that can predict red blood cells' responses to different circulation environments that can be accessed by pharmaceutical researchers and bioengineers to understand disease mechanisms and optimize biomedical device designs.

The bottom line is, don't be afraid to step outside your comfort zone and ask the difficult questions that no one has the answer to. And after you pose the question... find the answer! Setbacks and failures only bring you closer to success, so never be intimidated by the prospect of tumbling a few times while walking the road to success :)



MEET THE 2019 DVSF GRADE 10 SILVER MEDALIST—Carter Gassler, Avon Grove Charter School, West Grove, Pennsylvania. He researched "Multi-Terrain Robot."

Carter shares the inspiration for his research:

One of the most crucial parts of a successful science fair entry is finding inspiration and picking the right project. For me that inspiration came from an unlikely place. Over the summer, I took a trip to Alaska with my family, and during a hike, I noticed a centipede crawling on the ground. Its motion intrigued me and, long after it passed, I continued to think about how I could replicate it with a mechanical system. When I returned home, I began work on a centipede robot, and the next thing I knew, it had qualified for ISEF.



MEET THE 2019 DVSF GRADE 10 BRONZE MEDALIST—Carolyn Almonte, Youth Achievers Committee, Burlington, New Jersey. She researched "The Effect of Chronic Exposure to Artificial Light at Night on the Development & Fecundity of *Manduca sexta*." Carolyn is a two-time finalist in the middle-school Broadcom MASTERS competition.

Carolyn describes her experience as she learned the research skills that led her to a winning project:

Ever since I was very young I have been fascinated by insects. I used to carry a bag of plastic toy insects everywhere I went. One of the first phrases I read was "ant farm" and to my parent's dismay I wanted one for my birthday. I got that ant farm and over the years my love for insects grew. I would spend hours viewing the beehives at local museums in search of the queen or looking at the Madagascar hissing cockroach tank hoping to see one molt. I now enjoy spending time observing insects in their natural habitats hoping to snap the perfect picture.

Alarmingly we could be in the middle of an "insect apocalypse." Biologists have discovered a sharp decline in insect populations, which could spell disaster for the global ecosystem. Insects are critical as they are a source of nourishment for bats, birds, reptiles, and other animals and keep 80% of the world's plant life alive. Specifically in the Northeastern United States, hawkmoths, along with other members of the family *Saturniidae*, are in long-term decline or have been locally eradicated. One suggested hypothesis for their decline is the disruption to their normal day-night cycle by outdoor artificial lighting. To date, no firm link between artificial light at night and population declines in any moth species exists, so I set out to investigate sublethal effects that may cause artificial lights at various levels of brightness on moth development rates and growth through their life cycle and their reproductive potential. My results show that continuous exposure to bright white lights is

detrimental to moth development and reproduction rendering them unable to reproduce. In order to protect hawkmoths, outdoor white lighting should be more yellow in color, dimmed, and equipped with shields or hoods to reduce the light spilling to the surrounding wildlife areas.

I encourage other students to pick projects that interest them. Explore your passion. The best part of my project was turning a room in our house into a hawkmoth rearing laboratory of sorts. The worst part of my project was cleaning up everything that came with rearing hundreds and hundreds of hawkmoths from egg to adult moth. At times it seemed like a never-ending sea of caterpillar frass, but the long hours were worth every minute because I am doing the type of research I want to do as my profession. I am honored to be an ISEF Finalist and am excited about raising awareness of the lesser-known pollinator, the hawkmoth.

9th Grade Fair



MEET THE 2019 DVSF GRADE 9 GOLD MEDALIST—Flavien Moise, Council Rock High School, Newtown, Pennsylvania. Flavien researched "Drug to Defeat Diabetes: Comparing Diabetes Drug Treatment Efficacy after Metformin Using Big Data."

Flavien recounts the process of finding a project idea and completing the research:

I had a neighbor named Robert, an 80-year old man who is struggling with diabetes. Over the summer, I attended a computer science camp, and learned about how big data has already revolutionized several industries. I took my love for computer science and the fact that my neighbor was suffering from diabetes, put them together, and my science fair project was born.

This project took several months, and required patience and determination: building new algorithms, accounting for incomplete data, analyzing results, and researching many diabetes regimens were only some of the challenges involved. In the end, I got exciting results. I hope that my analysis and conclusions will help the healthcare industry provide personalized treatments, allowing people who suffer from diabetes to live longer, more comfortable lives.



MEET THE 2019 DVSF GRADE 9 SILVER MEDALIST—Maria Karakousis, Masterman School, Philadelphia, Pennsylvania. Maria researched "Nature's Water Filters: The Impact of Global Warming on the Filtration Efficiency of Mussels."

Maria tells us about the project:

Did you know that nature is equipped with its own water filters? Mussels are filter feeders, meaning they serve as a natural filtration mechanism that removes harmful algae from water systems. They are increasingly being used in freshwater bodies around the globe as a natural method to decontaminate and clean up algae-infested water sources. Little is known on the impact of rising temperatures (resulting from global climate change) on mussels' ability to do their job. The purpose of my study was to determine the impact of increasing temperatures on mussels' efficiency in effectively filtrating bodies of water. During my study, I had the very special opportunity to observe and care for a dozen young native mussels. My younger brother helped me stand them all up in an aquarium holding tank, and we made sure that they were buried in a layer of sand at least four cm thick! When we first deposited the mussels there, the tank water was murky and turbid, and we could see the particles of sand and gravel suspended in the water. When we had finished placing the young mussels in about a dozen neat rows, we left them with an aerator to eat dinner. When we returned, we found much to our surprise that the tank water looked to be crystal-clear! While we had been busy filling our stomachs with chicken soup and rice, the mussels had been intaking all of the sediments floating around and effectively clearing their water. This display of mussel water filtration made me realize what special creatures they are, and that we should strive to care about their species if we care about the safety of our drinking water. I think that we can draw inspiration from mussels to do in our own habitats what they do, which is to diligently work to keep our environment clean.



MEET THE 2019 DVSF GRADE 9 BRONZE MEDALIST—Matthew Sparling, Penncrest High School, Media, Pennsylvania. Matthew researched "Evaluating Pollution Concentrations with a Drone."

In his own words, Matthew shares his story:

I have been fascinated with aviation since I was very young. For my project, I built my own quadcopter (**not** from a kit) to evaluate pollution concentrations at different altitudes. Something I learned during this project was that safety procedures are essential with pre-flight checks, following FAA rules during flights and then post-flight maintenance to ensure the safety of everyone in the area. One of the most exciting and unexpected experiences

was when a red-tailed hawk attacked my drone during a test flight (The hawk was not hurt and I was able to safely land the drone). I encourage everyone who is passionate about a topic to read as much as you can about it and to not be afraid to reach out to people who have knowledge and experience. And most importantly, have fun with it and aim high.

Team Fair



MEET THE 2019 DVSF TEAM MEDALISTS—Riya Chaturvedi and Saarth Chaturvedi, Eastern High School, Voorhees, New Jersey; Vijay Ramu, Cherokee High School, Marlton, New Jersey. The team members worked together to research "Antimicrobial and Antibiotic Activities of Flora from the Burlington and Camden Counties against Aerobic and Anaerobic Bacteria."

Here are their perspectives on working together in this project.

Riya:

My top interests and hobbies have always been dance, singing, music, and sports. But one day, our inspirational mentor, who is a senior researcher at the University of Pennsylvania, opened up a new window for me. As we learned a lot from our project and gained a lot of knowledge from our mentor, we had some moments of laughter and bonding. I remember when the three of us were goofing around, our mentor came and told us to "be serious" and started laughing. At first, we were all a bit confused as to why he was laughing. He then reminded us of one of our bacterias, *Bacillus cereus*, which is utilized in our project and is shortened to *B. cereus* (pronounced the same way as "be serious"). After a second or two of processing the joke, we joined in and had a good laugh. Yes, there were some tiresome days where we were up till 12:00am throughout the school week, diligently working on our project, but all the fun, the knowledge, and the experience we gained from this made it all up. Dance, arts, and sports still do remain as some of my top interests. However, thanks to my mentor and this valuable experience, science has now been added to the list as an interest and potential career option!

Vijay:

Although it may not seem true, an antibiotic's shelf life is relatively minute. This is because of a growing epidemic: antibacterial resistance. Antibacterial resistance occurs when a bacterial species is exposed to an antibiotic for a prolonged period of time that it slowly becomes resistant to the antibiotic. This also has to do with the fact that most bacteria are able to reproduce rapidly and their genes mutate very frequently.

Once I realized how much of a problem antibacterial resistance was, I was determined to try and find novel antibiotics in our local community, the Camden County area. To do this, I set out to four different locations and collected a total of 24 plants. I then took these plants to our lab and crushed them with methanol, using a mortar and pestle. Once I let these plant leaf extracts settle in order to have the liquid and solid somewhat separate, I centrifuged them to obtain only the pure liquid extract. Finally, I tested these liquid extracts on four different bacteria, finding positive results against three of these bacteria.

Saarth:

This project was a completely new experience for me. Before this project, my interests mostly consisted of computer science and sports. Through this project, I learned about new bacteria and plants, which developed a new interest in microbiology for me. For our project, we tested for antibiotic activity in local plants against certain bacteria. Throughout this process, along with learning about the plants and bacteria, we learned how to use different equipment as well. For example, we learned how to use a centrifuge, pipetteman, and different features of Excel, which we have never used before. Although there were nights where we stayed up late working, this project has been an amazing experience; along with learning a lot, I had a lot of fun working with my team.

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MEDALISTS' ABSTRACTS

Amanda Ahteck

"A Novel Low Cost Resistive Soft Crochet Stretch Sensor as Applied to a Wearable Bluetooth Keyboard Text Input Device--midiKEY"

Wearable technology relies on the use of sensors to monitor bodily movement. Soft, flexible, and durable sensors are needed in devices for everyday use. Here, I present a novel method for creating stretch sensors using commercially available stainless steel conductive thread in a crocheted chain of hooked loops. Sensing properties are enabled by the geometry of the loops reducing the cross-sectional area of the conductive thread when under tensile stress, changing its electrical resistance. If the piezoresistive sensor is attached to the analog inputs of a microcontroller (Arduino Lilvpad) supplying a constant current, the voltage changes can be read when the sensor is pulled and relaxed. The analog read voltage drops are converted to digital signals past an indicated threshold. The signals can find application in wearable electronics monitoring flexion of a joint. Five sensors are attached to the controller, one monitoring each finger while looped into a ring worn above the second knuckle. With multiple combinations of sensor input, the chorded keyboard interprets each pattern of signals to a different alphanumeric key (ex. Flexing finger and thumb will output the key "a"). This creates a wearable Bluetooth human interface device keyboard, the midiKEY. The technology in the midiKEY may have applications in open-hand VR/AR controllers, musical instrument control, assistive humancomputer input for the visually and physically disabled, and in physical therapy devices for rehabilitating hand strength and flexion.

Isha Mohapatra

"Heat Loss Through a Wall Made with Optimized Insulating Bricks"

Porous bricks are much more insulating than dense bricks. However, my past research has shown that by increasing the porosity through the addition of sawdust to burn away during firing, the crushing strength is reduced. After using the Taguchi Method, a process optimization method, to determine a set of 3 optimum bricks (labeled Experiment 1, 2, and 5) that were both insulating and strong last year, I decided to finally build these bricks into walls and test their heat transfer properties.

The Control and the 3 optimum brick recipes were mixed, fired, stacked together into a 3 X 3 brick array, and finally surrounded by insulation. To test the heat transfer property of the brick, all sides of the wall, except one, had to be enclosed by insulation. Three heaters were placed on a slab of insulation, then the stacked bricks with the insulation surrounding them were placed sideways on top of the heaters. Three thermocouples were placed on the bottom of the bricks to record the temperature directly from the heaters and three were placed on the top to record the temperature on the top of the bricks. The heaters were connected to a rheostat and the thermocouples were connected to a data acquisition system. The rheostat was then set at a certain voltage. Data was recorded starting at room temperature for 2 hours.

It was found that the Experiment 5 brick had a lower thermal conductivity (more insulating) due to a higher temperature difference between the bottom and the top thermocouples. The Experiment 1 and 2 bricks were similar in thermal conductivity and had similar temperature differences. However, all three of these bricks had higher temperature differences than the control brick, confirming that they were more insulating.

Claudia Schreier

"Algal Fertilizer: Enhancing American Beachgrass Growth on Dunes"

The presence of healthy dune grass is critical to ensure that sand dunes are stabilized and able to thrive in the harsh coastal environment. This research was conducted with the intent of developing a viable biofertilizer from Ulva lactuca, a green, sheetlike macroalgae that grows prolifically; by mixing agar with harvested algae, a dry, solid fertilizer was produced. In this investigation, the algal supplement was compared to a commercial fertilizer that is currently used to supplement Ammophila breviligulata on Island Beach State Park. The commercial fertilizer, synthesized from treated waste, includes traces of pharmaceuticals and heavy metals, and could potentially be harmful to marine species. 600 Ammophila breviligulata were fertilized with either the algal supplement, commercial fertilizer, or a non-fertilized control. In July and November 2018, the chlorophyll content of leaf samples, plant thickness, and overall survival rates were recorded, collected from two sites within the park. The data was utilized within an Overall Plant Health scoring system, with each parameter counting for 100 points for a possible 300 points. Based on this system, the algal supplement consistently scored higher than the commercial and control treatments, demonstrating that algae-based fertilizer can provide an environmentally friendly alternative to commercial fertilizers while also being an efficient and economically viable option.

Neil Deshmukh

"An Adaptive, Low-Cost Device for Automated & Offline Medical Analysis Utilizing Neural Networks with Reinforcement Learning Optimization"

Diagnosing diseases automatically has been an immense challenge, owing to their variable properties and symptoms. On the other hand, Neural Networks (NNs) have developed into a powerful tool in the field of machine learning, one that is showing to be promising at computing diagnosis even with inconsistent variables.

In this research, a low-cost device was developed for straightforward analysis and treatment of human diseases, using NNs. By utilizing NNs, optimized through reinforcement learning, the device can detect diseases and conditions, all automatically, utilizing end-to-end deep learning. It does so with an extremely high accuracy rate, comparable to medical personnel. The Deep NN algorithm can identify 1557 various diseases, along with providing treatment advice. Biometric values such as oxygen saturation and electrocardiogram (ECG) values are calculated using a Recurrent NN (RNN), developed to detect anomalies: myocardial arrhythmias and ischemias. A Convolutional NN is on the device to identify and segment dermatological lesions. Vocal tone is analyzed, through an RNN, to identify biomarkers of cognitive decline. These algorithms all run on a Raspberry Pi processor. This device can augment doctors by speeding up the time needed for diagnosis by pre-analyzing the user and providing estimated conditions. This scalable method of detecting anomalies before they pose a threat, holds the ability to create clinical impact around the world by profoundly increasing access and scope of medical care.

Overall, this device will both alert physicians to high-risk patients, while making the doctors' analysis much more efficient; therefore, saving people, while decreasing costs and time.

Zoe Frantz "Testing of the Future"

As many schools are choosing to integrate technology into the classroom, such as iPads and laptops, administrators are pushing that state-mandated standardized tests are also taken on the computer. This poses the questions: "Are the standardized test scores of students affected by the method on which they take the exam (paper or computer)?" and "Are the test scores of those tests taken on the computer affected by the number of years that a student has used a computer in school?"

In conducting this study, 596 participants in grades 4-9 were given a standardized test on paper and online. These tests consisted of five english and five math questions from released state standardized tests. To fully counterbalance the experiments, students were randomly selected to four different testing groups, which determined the order in which the student would take their online and paper test, and the test form. The participants paper and online scores were then analyzed and compared against each other.

At the conclusion of the study, it was determined that the method a test is administered affects the test taker's score. Combined across all grades, there was a statistically significant difference for standardized tests taken on paper and on laptop. When a student took a standardized test on paper, they received a 4% higher score than when they took the exam online. When the scores of the students were analyzed by grade level, it was determined that the standardized test scores of students in grades 8 and 9 had a larger mean difference between their paper and online test score. From these results, it is theorized that student performance on standardized tests depends on the method in which the students have taken their standardized tests in the past.

Caden Traversari

"The Effect of Endocytosis Altering Substances on Vacuole Formation in Tetrahymena"

This project was pursued in order to study how statins and dimethyl sulfoxide (DMSO) affect vacuole formation in Tetrahymena. Both statins, which are drugs which help to lower cholesterol, and DMSO, which is a common component in bladder inflammation medication and topical antibiotics, affect endocytosis, an essential component in the process of vacuole formation. Because statins increase the rate of endocytosis, the rate of vacuole formation in Tetrahymena that have been introduced to a statin solution should increase. Contrastingly, because dimethyl sulfoxide decreases the rate of endocytosis, the rate of vacuole formation in Tetrahymena that have been introduced to a DMSO solution should decrease. In two experiments, Tetrahymena were introduced to either a 1% fluvastatin solution or a 1% Dimethyl Sulfoxide (DMSO) solution. After 10 minutes in the solution, Tetrahymena were placed on a slide with 1% India ink solution and the average number of vacuoles present after 2, 4, 6, 8, and 10 minutes of feeding on the 1% India ink solution were then observed. These results were compared against a control Tetrahymena group, which had been introduced to neither variable substance. The results of the three test groups were statistically significant (all p-values < .001) and showed that compared to the control Tetrahymena, the Tetrahymena introduced to the 1% fluvastatin solution experienced about a 58% faster rate of vacuole formation, while the Tetrahymena introduced to the 1% DMSO solution experienced about a 32% slower rate of vacuole formation. The results support both hypotheses, as the 1% statin solution increased and the 1% DMSO solution decreased the rate of vacuole formation in Tetrahymena.

Prathysha Kothare

"Re-envisioning Erythrocyte Dynamics: Computational vs. Experimental Modeling of RBC in Capillary Shearing"

During circulation, red blood cells (RBCs) experience shear stress. While RBCs are mechanically robust, extreme flows may compromise the spectrin network and lipid bilayer, leading to hydrophilic pore formation that can expand and cause hemolysis. Understanding spectrin mechanics and pore formation is of great importance in biomedicine. Over 1.7 billion people suffer from blood-related disorders or are life dependent on ventricular assist devices (VADs). Such VADs and microfluidic blood testing devices must be appropriately designed to keep RBCs intact, while gene and drug transfection therapies rely on transient RBC poration. The experimental scope of this project involved reverse aspiration to squeeze RBCs under high shear and study hemolysis using fluorescence microscopy. An alternative approach under investigation utilizes UV lithography to design long residence channels for spectrin studies using atomic force microscopy. Computational modeling of RBCs under pulling forces provides understanding of spectrin deformation. However, since atomistic simulations are costly, inefficient and largely inaccessible, a coarse-grained (CG) model was developed and validated. Pore formation was studied through development of a DPPC (1,2-dipalmitoyl-sn-glycero-3-phosphocholine) bilayer model subjected to equibiaxial quasistatic stretching via a CG forcefield. Effects of bilaver composition (cholesterol/asymmetry) and increasing shear rates were studied via potential energy, partial density, and surface tension analyses. The goal of this research is to produce both experimental and computational insights into straininduced RBC poration to explain unknown blood disease mechanisms, allow for better VADs, or explore transient pores for targeted drug delivery.

Carter Gassler "Multi-Terrain Robot"

When it comes to small, versatile, capable, and durable robots that can be used for search and rescue or exploration, there are few, if any, available. The goal of this project is to design a small robot that could be used to search for earthquake victims, inspect equipment in tight spaces, and explore unknown or dangerous environments. The robot is based off of a centipede, meaning that it has pairs of legs connected to discrete, articulated body segments. The robot's legs are driven by a motor connected to a central driveshaft. At each junction between body segments, the driveshaft is made flexible using a universal joint. A worm gear lies on the driveshaft inside each body segment. These worm gears drive worm wheels, which turn shafts perpendicular to the driveshaft. These shafts drive the legs. The early prototype's

body segments were designed in SolidWorks and 3D printed, while the driving mechanism and legs are constructed from LEGO pieces. The current iteration is more durable, larger, has a metal drivetrain, and a steering system. The robot is capable of walking over uneven terrain and streaming video feedback to the operator.

Carolyn Almonte

"The Effect of Chronic Exposure to Artificial Light at Night on the Development & Fecundity of *Manduca sexta*"

The purpose of this experiment is to investigate the effect of artificial light at night (ALAN) on Manduca sexta development and fecundity. Hawkmoth populations in the Northeastern United States are in long-term decline. ALAN is a potential contributor; however, no firm link between ALAN and population declines in any moth species currently exists. The amount of the Earth's surface exposed to ALAN increases year over year. Cities worldwide are switching to brighter and bluer light emitting diode (LED) lights. White-lights of varying correlated color temperatures (CCT) and illuminance (lux) were investigated to determine the impact of both on Manduca sexta. Development and reproduction experiments were performed. Pupal size and time to pupation and adult emergence were captured to measure development. Female reproductive potential was tested by measuring adult moth egg production based on the sum of total eggs laid plus eggs remaining in ovarioles. Male reproductive potential was tested by counting eupyrene sperm bundles found in the seminal vesicles of 2-day old virgin males. One-way analysis of variance and Tukey's method was used to determine significant differences between test group responding variables. Only the treatment group exposed to the lowest CCT (2700K) and illuminance (1lux) did not exhibit a significant negative impact on both development and reproduction when compared to the control. Results show the higher the CCT and illuminance, the greater the negative impact on *Manduca sexta*. Therefore, outdoor lighting should be 2700K or less, dimmed, and equipped with shields to prevent light from spilling into surrounding wildlife areas.

Flavien Moise

"Drug to Defeat Diabetes: Comparing Diabetes Drug Treatment Efficacy after Metformin Using Big Data"

Diabetes affects 30 million Americans, and costs \$300 billion a year. The first regimen prescribed to new patients is usually metformin: it is very effective at reducing the level of sugar in the blood and is relatively inexpensive. However, diabetes gets worse over time. After metformin, there are many other drugs to choose from (including expensive ones). The purpose of this project is to find which regimen is best at treating diabetes after metformin (measured by reduction in HbA1c), and which

demographics affect regimen efficacy. Raw data with about 1 million patients with metformin comes from Symphony Health Solutions . This research is unique as it considers all classes of treatments, uses Real-World Evidence and big data sets with demographics not available to the average physician . An algorithm was written to identify regimen changes, find relevant patients, and calculate change in HbA1c level. Results are significant: first, dual therapies (Metformin + other drug) almost always are superior to monotherapies. Second, most of the expensive drugs are not statistically different to a generic regimen (MET+TZD). If 100,000 patients switched from these regimens to MET+TZD, roughly 500 million dollars would be saved a year. Finally, some regimens work better for males (DPP4+MET+SFU), and others work better for females (TZD). SGLT2 works better for African Americans and MET+SFU works better for Caucasians. In conclusion, patient demographics, such as gender and race, should be taken into consideration in order to offer patients personalized prescriptions.

Maria Karakousis

"Nature's Water Filters: The Impact of Global Warming on the Filtration Efficiency of Mussels"

Background: Mussels are increasingly being utilized as a natural method to remove and filter harmful algae and other natural debris from our water systems. In the context of concerns for climate change, little is known regarding the effect of temperature fluctuations on mussels' filtration efficiency. Previous studies have shown modest impact of temperature on specific mussel species except at very low temperatures. This study investigates the effect of temperature on *Utterbackiana implicata*, a species native to North America.

Methods: The filtration efficiency of mussels was studied at three different average water temperatures: 11.5 degrees C, 17 degrees C, and 23.5 degrees C. Four mussels were placed in approximately 1 L of conditioned water, with one group of four mussels observed in each of the three temperature environments. Water turbidity was created using algae Instant Algae Shellfish Diet 1800 and assessed over time using a 2100P turbidimeter (Hach, USA). Experiments were conducted in triplicate. Appropriate control experimentation (without mussels) was also performed.

Results: Filtration efficiency (DELTA turbidity/DELTA time) was 0.86±0.47, 2.06±1.18, and 0.64±1.22 NTUs/hr at average temperatures 11.5 degrees C, 17 degrees C, and 23.5 degrees C respectively.

Conclusion: Variation in temperature over a modest range does not significantly impact the filtration efficiency of the mussel *Utterbackiana implicata*, which is consistent with prior published reports.

Matthew Sparling "Evaluating Pollution Concentrations with a Drone"

Introduction

The purpose of this experiment is to bring awareness to air pollution. In recent years news reportings on severe wildfires, such as the California and Texas wildfires, have been focused on the millions of dollars in damage. But those fires have also released dangerous levels of Particulate Matter 2.5 (PM2.5) into the air. Some of the negative health effects that PM2.5 causes are coughing, shortness of breath, and irritation of the eyes, nose, and throat.

Problem Statement

The hypotheses for this experiment was if PM2.5 is in my test area, then concentrations will be greater at 29.1 meters.

Procedures

To test my hypothesis I used a home-built drone, with an Airbeam (PM2.5 monitor) secured on top. I collected air samples at ground level and at 29.1 meters in the sky.

Results

The data showed that there was an average of about 8 μ g/m 3 more PM2.5 at a height of 29.1 meters than at ground level.

Conclusion

The objectives and design criteria were met. This experiment could help map PM2.5 levels at a lower cost and potentially could save lives by informing people of any dangerous levels near them.

Vijay Ramu, Saarth Chaturvedi, and Riya Chaturvedi

"Antimicrobial and Antibiotic Activities of Flora from the Burlington and Camden Counties against Aerobic and Anaerobic Bacteria"

Antibiotic resistance by bacteria is a growing problem around the world. According to the CDC, antibiotic resistance is one of the biggest public health challenges of our time. In the US alone, an estimated 2 million infections and 23,000 deaths occur due to these resistant pathogens. Our goal in this study was to look for novel antimicrobial sources from the natural flora of our local counties. Over a period of one month we collected 24 plant leaves and extracted them with methanol. We tested them on four BSL-1 bacteria *(Serratia liquefaciens, Bacillus cereus, Pseudomonas putida, and Enterobacter aerogenes*). Of the 24 extracts tested, four of them *(Quercus marilandica, Contex)*.

Lindera glauca, Leibnitzia anandia, and *Amorpha fruticosa*) inhibited growth of *B. cereus, E. aerogenes, and S. liquefaciens.* None of 24 extracts inhibited the growth of *P. putida.* These results show that these four extracts are specific against a set of bacteria. The inhibition by *Leibnitzia anandia* was most robust against the three bacteria and comparable to 1mg concentration of the antibiotic amoxicillin. This gave us confidence to test these positive extracts for further experiments. We then made dilutions of the four extracts and found that they were all active up to 1:3 or 1:10 dilutions. In conclusion, we have been successful in identifying four plant sources that inhibit the growth of *Serratia liquefaciens, Bacillus cereus, and Enterobacter aerogenes.* Further work will be required to purify and isolate the active compounds and test for their efficacy against other pathogenic bacteria.

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