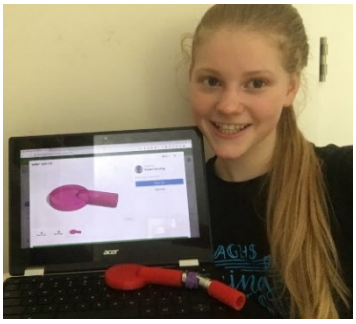
Delaware Valley Science Fairs

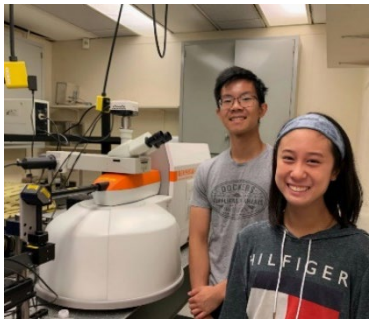
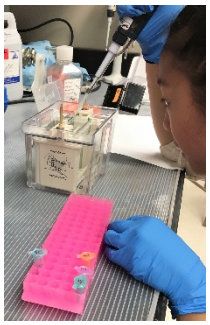
MEET THE MEDALISTS 2020

Vignettes and Project Abstracts of

DVSF Medal Winners in

9th through 12th Grades

Compiled by

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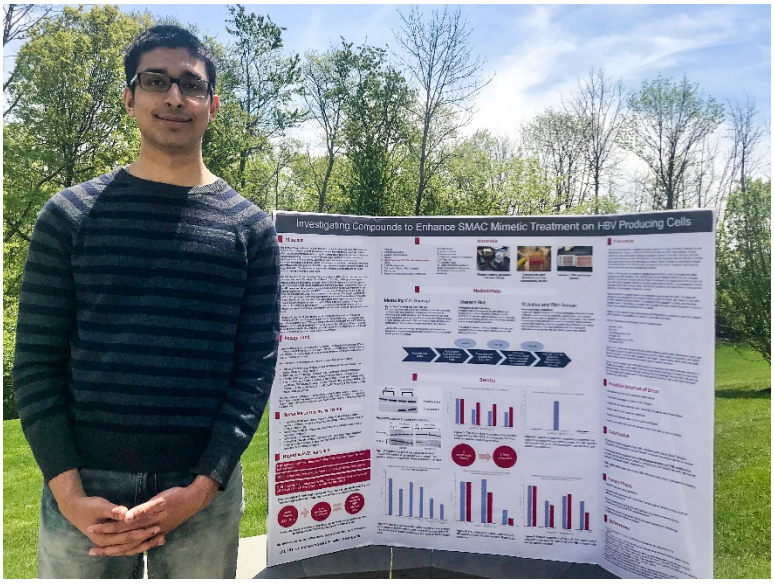
Delaware Valley Science Fairs

Delaware Valley Science Fairs

MEET THE MEDALISTS 2020

Below are vignettes of the medalists from the 2020 Delaware Valley Science Fairs.

12th Grade Fair



MEET THE 2020 DVSF GRADE 12 GOLD MEDALIST—Rishi Vaidyanath, Central Bucks High School East. His project involved *Investigating Synthetic Compounds to Potentiate SMAC Mimetic Targeting Agent*.

Rishi tells us about his project:

> I've been working in a field of molecular biology that studies cell death pathways and utilizes these mechanisms to treat Hepatitis B. Anchoring on a project plan was magnitudes harder than the actual experimentation itself. Last summer, I felt courageous enough to read articles on the infectious Hepatitis B virus (HBV), a pathogen that affects a large group of people in Asia. At first glance, most of the literature seemed intense, and whenever I saw new terminology, I would be sucked into the rabbit hole of unfamiliar concepts. I eventually learned to embrace the ambiguity and confusion. After weeks of background research, I felt ecstatic to

possess a small understanding of the science. As time went on, I realized my original conception of the project was nowhere close to where it ended up. Through trial and error, I had to adapt and toss out aspects of my plans that were not feasible in the long term. I realized that research is not a straightforward path, but rather a series of twists and turns that helped me think critically.

For my project, I screened and sought out compounds with anti-inflammatory properties to more effectively kill cells with Hepatitis B. More specifically, I wanted to confirm if cells infected with Hepatitis B are more likely to resist programmed cell death, and then find inexpensive compounds to mitigate this resistance for more effective killing. It consisted of growing my cells in petri dishes, transferring them to 384 well plates, and then adding my compounds for treatment. It was hard work for sure, but the end result of finding possible leads was incredibly rewarding. Through my project, I realized that drug discovery is definitely a field I am passionate about.

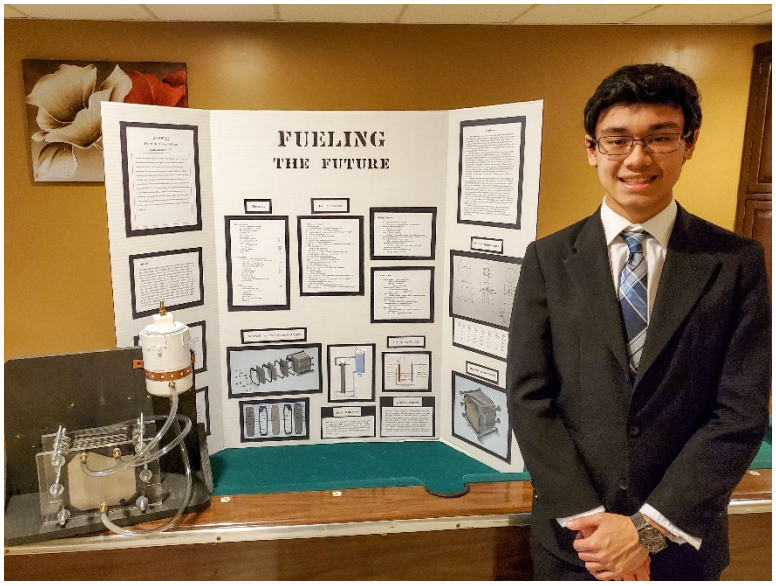
MEET THE 2020 DVSF GRADE 12 SILVER MEDALIST—Ariel Baiano, Marine Academy of Technology & Environmental Science (MATES). She researched *Developing a Novel Non-Reliance Posture Trainer*.

Ariel shares her experience:

> I started my postural journey three years ago with my investigation into the effects of poor posture on the human body. Using common household items and premier 3D-

printing techniques, I made my way to Intel ISEF 2018 with two huge spines and one even larger message: Stop slouching, it's ruining your body! Through hydraulic pressure gauges and elastic bands, I discovered evidence to support that poor posture contributes to spinal disc damage and posterior muscle stress—Now, we need a solution!

I am beyond honored to represent DVSF as a medalist in 2020 with the fruits of my arduous labor. For the past two years, I have been designing the Smart Wearable Automatic Posture Training Apparatus (SWAPTA): my personal invention that is a possible long-term solution for poor posture. As a wearable shirt that combines smart slouch-sensing technology, electromyostimulation, and shoulder girdle manipulation via muscle wire, the SWAPTA not only teaches the brain to recognize slouching but trains the body through muscle activation to correct it on its own! Thus, the SWAPTA is a progressive approach to posture correction that eliminates reliance on a rigid brace and the resulting muscle weakening. Although we cannot present in person, I am elated at the opportunity to share my work through the Delaware Valley and ISEF communities once again.



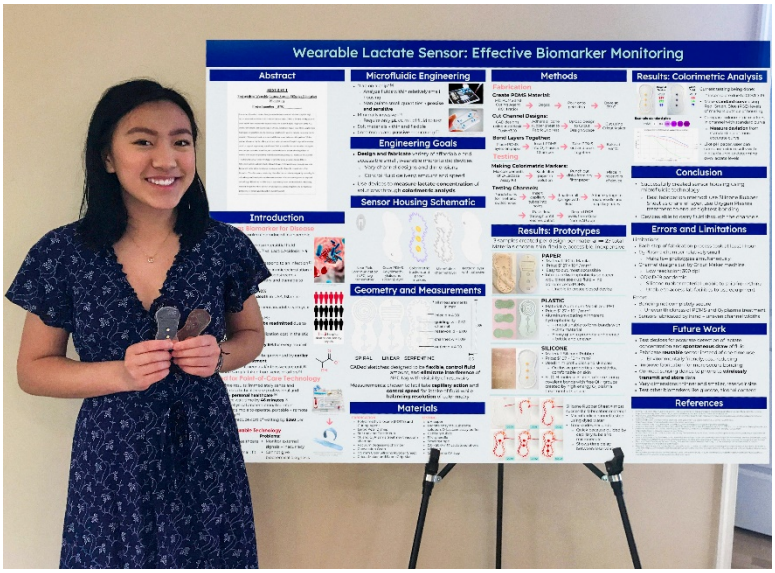
MEET THE 2020 DVSF GRADE 12 BRONZE MEDALIST—Christopher Gerhart, Souderton Area High School. His project is *Fueling the Future*.

Christopher shares wise words about his research:

> The best way to come up with an engineering project is to observe what's going on in the world. I got my idea by looking at current issues regarding alternatives to power and non-renewable fuels. Then came up with ideas by gathering information on my own and utilizing what I learned from certain classes. A good project will challenge

problem-solving skills and scientific thinking methods. Even if it doesn't work out in the end as intended, it is still important to reflect on what went wrong and learn from it.

11th Grade Fair



MEET THE 2020 DVSF GRADE 11 GOLD MEDALIST—Emily Wang, Germantown Academy. Her project is entitled *Wearable Lactate Sensor: Effective Biomarker Monitoring*.

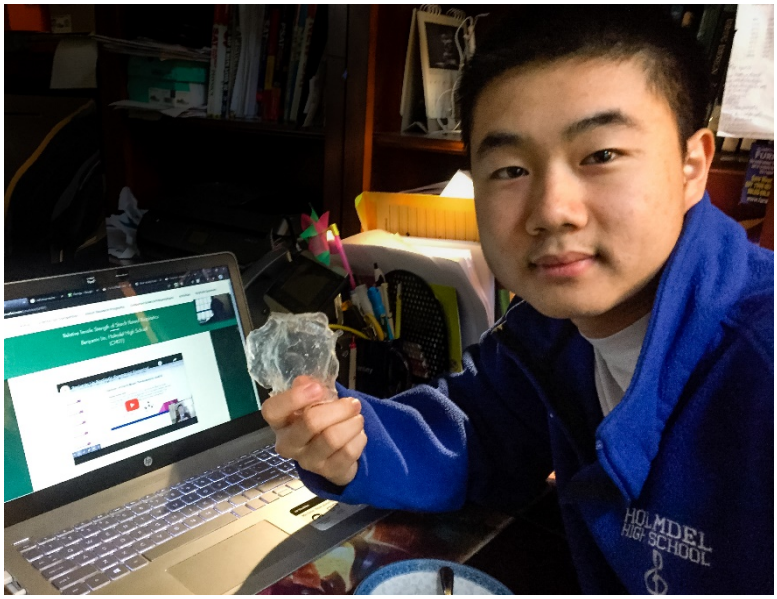
Emily shares her inspirations and the relevance of research like hers:

> It's late in the afternoon, and I'm on my way home after a long day in Philly. Exhausted, I plop down in one of the first few seats of the train, completely ready to take a nap. But, when I look up, I'm face to face with a little curly-haired girl smiling at me, saying, "Hi! I'm Miss Sepsis." Normally, I don't pay much attention to the ad posters SEPTA hangs on the train, but for some reason, Miss Sepsis with her pink skirt and heart-shaped band-aid drew in my curious mind. "Every year, a least 1.7 million Americans develop sepsis, and nearly 270,000 die," she says. I'm fully awake now. Why are these numbers so large, and why had I never heard of sepsis?
>
> I spend that night perusing through medical websites, reading the stories of sepsis patients. Images of tiny infants and the weak elderly giving up milliliters of blood in order to measure their lactate levels develop in my mind. My heart sinks for the 80% of deaths from sepsis that could have been prevented by an earlier diagnosis but weren't because of issues like cost or accessibility. I shut my laptop, and only one question comes to mind: *what can I do to help?* Thus, I began my quest to find a potential solution, researching, designing, and fabricating a minimally invasive,

affordable, and user-friendly point-of-care device to make measuring biomarkers like lactate more personal and immediate!

Miss Sepsis has shown me that inspiration can strike at any time. In my project, I continued to draw from common objects I see around me: temporary tattoos inspired the microfluidic sensor housing, while pH paper inspired the colorimetric markers. When put together, these two seemingly trivial things can make the most effective device. After all, simple things are the ones that beg for innovation and creativity!

Reflecting on my project during the current pandemic, I'm struck by how important and relevant research like mine is in today's world. Now more than ever, there is a demand for readily available testing devices or kits, with quick turn-around time. I hope my project can contribute to the bioengineering and medical fields, helping everyone get the personal care they need, helping save lives.



MEET THE 2020 DVSF GRADE 11 SILVER MEDALIST—Benjamin Lin, Holmdel High School. His project is *Relative Tensile Strength of Starch-Based Bioplastics: Effective and Biodegradable Materials for Applications in Consumable Manufacturing*.

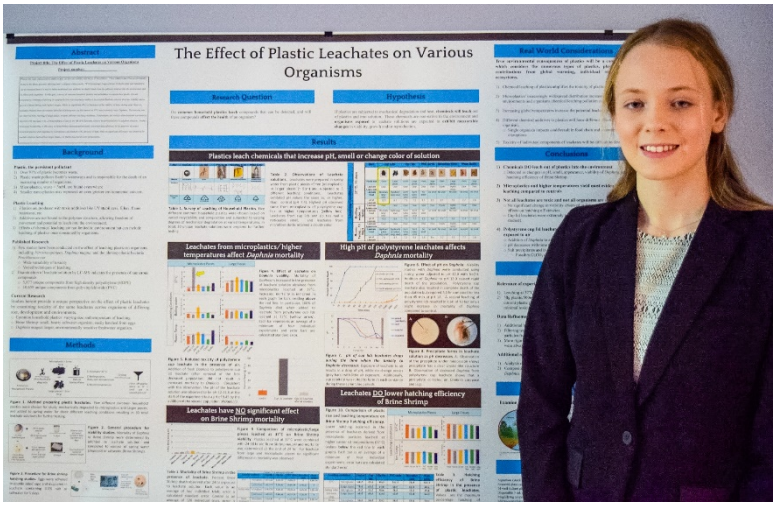
Benjamin explains how his project evolved here:

> It was probably around freshman year one day when my dad brought home some delicious take out from a nearby restaurant. I didn't even notice the unique texture of what held the food until my family and I finished it all and I picked one up to examine. I realized that a few of the small plates were made out of a type of bamboo. It was too thin and fragile to be used again but just enough to hold the spring rolls I was chowing

down. So, I asked myself: why aren't more disposables made with this kind of natural, biodegradable material?

Fast forward a year, I'm in my research class when this memory pops back into my head, and it inspires me to look into different kinds of bioplastic. After looking through some studies, I learned that most of the bioplastic materials commercially available today lacked the necessary strength and durability for common use. I decided to test different vegetable starches to find which could possibly yield an optimal bioplastic. And thus began the chaotic few weeks of running back and forth between my research class and the physics lab in my school to make and test the tensile strength of the bioplastics. I'll never forget how numb my thumb felt from pulling on the hundreds of samples and breaking them in order to get a measurement. To my surprise, I was able to find a starch-based bioplastic that was significantly stronger and more flexible than the other samples.

Looking back at it all, I never knew how far I was able to come with the use of just a few household kitchen supplies. But I am really glad that the success of my experiment and small discovery became one step closer to widening the use of bioplastic consumables, putting a dent in our society's plastic problem, and bringing us on the path for a greener future.



MEET THE 2020 DVSF GRADE 11 BRONZE MEDALIST—Lillian Miller, Perkiomen Valley High School. Her project looks at *Effects of Plastic Leachates on Various Organisms*.

Here is Lillian's story about why she studied microplastics:

I have always found microplastics to be a very interesting area of study. These particles, sometimes barely even visible, cause an assortment of problems that are not seen with regular-sized plastics pollution. Microplastics, which can be introduced into the environment in a variety of ways -- through degradation of larger plastics and cosmetic additives -- can have profound physical effects on organisms. Similar to how

larger plastics can harm large organisms, smaller plastics pose this threat to smaller organisms. Last year I studied this effect of microplastics in my project "Effects of Microplastics on *Daphnia*." However, microplastics also present a variety of problems that are much less obvious, such as the unique threat they create when they leach chemical additives or act as a vessel for other chemical pollutants. After doing a project studying how microfibers could harbor bacteria very effectively, I wanted to do a study looking at how plastics could pose a chemical threat to organisms, resulting in my project this year: "The Effect of Plastic Leachates on Various Organisms."

This project presented me with a variety of challenges. First off, many common plastics are regulated, so uncovering any possible toxicity would be very hard and it would likely be a subtle effect. This led me to undertake a broad survey of plastics and organisms, as I knew I would see a variety of results. I did, in fact, see a broad range of results, from absolutely no effect to 100% mortality rates and everything in between. Despite such a variety of effects, one common thread was that the microplastic leachates were always more harmful than the whole plastics leachate solutions, likely due to the increased surface area of the smaller particles.

Since I was a child I have always loved being in and around the water, and I think it is very important that we continue to study and understand the various threats posed to all aquatic environments, especially by microplastics.

10th Grade Fair

MEET THE 2020 DVSF GRADE 10 GOLD MEDALIST—Olivia Takla, Marine Academy of Technology & Environmental Science. Olivia studied *Using Machine Learning and Smart Insoles for Early Detection of Autism Spectrum Disorder*.

Olivia's story:

I had always known that those with autism spectrum disorder (ASD) have cognitive impairments; but, after noticing that a relative of mine, diagnosed with autism, had awkward gait compared to his teammates during a soccer game, I began to research whether those with ASD had physical impairments as well. I was able to find that autism is related to accompanying gait abnormalities. The previous year, as a freshman, my research project involved analyzing the effectiveness of various types of insoles to benefit postural control. With this research fresh in my mind, I thought to create a detection system using the typical gait patterns of children with autism through the use of a smart insole. This year's research has truly opened my eyes to the potential that the sciences have around us, and it further fortified my deep-rooted passion in the human body and anatomy.

MEET THE 2020 DVSF GRADE 10 SILVER MEDALIST—Susan Deering, Avon Grove High School. Susan's project involved *Designing a Prosthesis to Aid in Right Hand Motion of Violin*.

Susan shares the influences that brought her to this research:

> When I was in fourth grade, I started learning to play the violin, and it has become a passion and a major part of my life since. This past summer, I had recently started studying with a new teacher and also took individual lessons from a number of other teachers who helped me really understand proper bow arm technique. While I was studying this technique for musical performance applications, I also came to learn about the nuanced and complex mechanics behind basic bow technique. This inspired me to try to apply these mechanics in a design that would allow someone without use of their wrist and hand to use the bow on the violin. I was quickly able to locate several custom and commercial prostheses to aid in bow motion but found that none of these were truly effective in all or most essential aspects of basic bow motion. I completed research on amputation and biomechanics and worked with a team of local certified

prosthetist-orthotists, and I also consulted and studied the technique of a professional violinist. From here, I decided on some specific engineering goals and my intended patient (transradial or wrist disarticulation amputee). A few months were spent on the process of designing, modeling, constructing, and testing the prototype before I came to the current, successful prototype I have now. Though I have to use myself, a non-amputee, to test, it works very successfully without use of the hand or wrist and I hope to continue to work with my local prosthetics clinic to make this design accessible to amputees in the future!

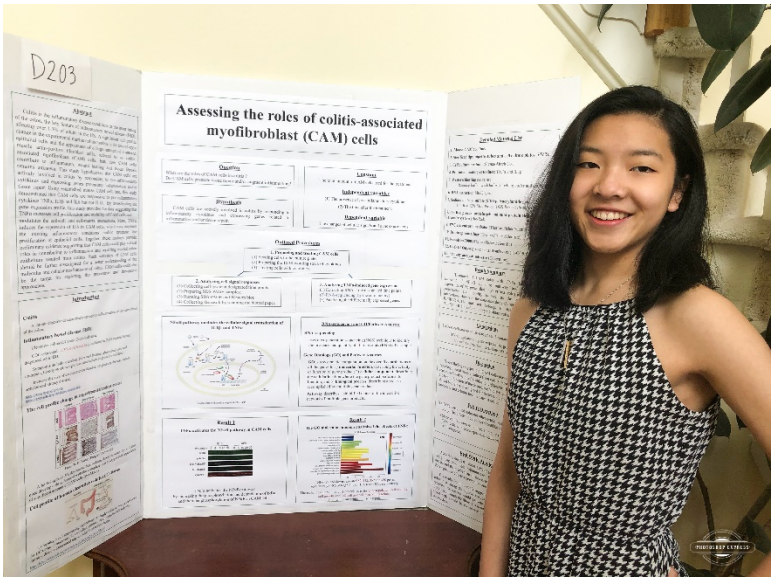
MEET THE 2020 DVSF GRADE 10 BRONZE MEDALIST—Jen Parsons, Upper Dublin High School. Her project looked at *Optimal Hair Bun Placement to Reduce Drag for Swimmers*.

Jen describes the observations that led to her research:

> Last summer while I was at swim championships, I noticed a difference in how the water moves around a swimmer based on their skill level. When I compared an 8-year-old to an 18-year-old, there was a clear difference in how the water moved around their head. The water moving around the faster swimming 18-year-old moved over their head, whereas the slower swimming 8-year-old had the water moving around their head. I also noticed that some of the female swimmers had long hair and that they had to put their hair up into large buns in their swim caps. Some girls put them lower on their head and some put them higher, which made them look like sharks lol. These observations were interesting to me because it appears that the water moves differently when a swimmer is moving faster than when a swimmer is moving slower. After observing this, many more questions came to mind. One of the

primary questions I had was whether the location of the bun in a swim cap affects the amount of drag produced. This sparked the start of my science fair project.

9th Grade Fair

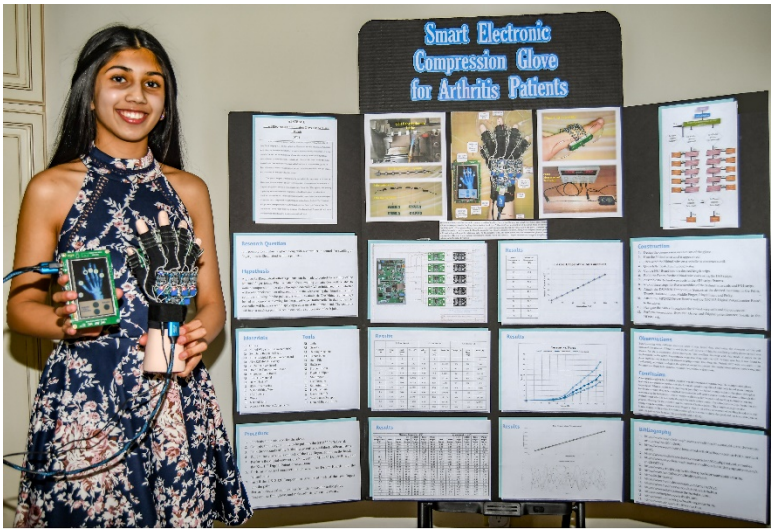


MEET THE 2020 DVSF GRADE 9 GOLD MEDALIST—Lucy Wang, Methacton High School. Lucy researched *Assessing the Roles of Colitis-Associated Myofibroblast Cells*.

Lucy talks about the wide variety of projects she has tackled and the value common to all:

> "Irritable bowel syndrome (IBS)" was the keyword in an advertisement while watching my favorite show. I remembered this word after watching this advertisement too many times. I had no clue about it. Luckily, before I forgot, my supervisor mentioned this word when we discussed a potential project. After searching on my phone, I learned that IBS is a digestive tract disorder that affects about 45 million people annually in the United States. I thought I could help. Although I did not completely digest the concepts yet, I decided to focus my project on them. With some techniques that I learned last year, I started to culture the "colitis-associated myofibroblast (CAM) cells'' isolated by my supervisor from colitis tissue of mice, which is commonly used as an experimental model to study digestive tract diseases, like IBS. In this disease, inflammatory cells are well-recognized key factors. The roles of CAM cells are not clear. To explore the roles of CAM cells, I started with a simple experiment to determine whether they are involved in inflammation. Indeed, I found they are! I wish the novel function of CAM cells suggested by my study could be an important piece to solve the puzzle of IBS.

With curiosity, naive questions, and a little ambition, I had stained teeth, collected soil to culture bacteria, made yogurt in previous fairs, and this time I used state of the art technology to study colitis. Throughout all of my projects, I had a great experience working with scientists to learn scientific methods and to get my hands dirty. It is always exciting to participate in the science fair every year with my peers, sponsors, and judges. It is also fun to meet other students who share similar interests.

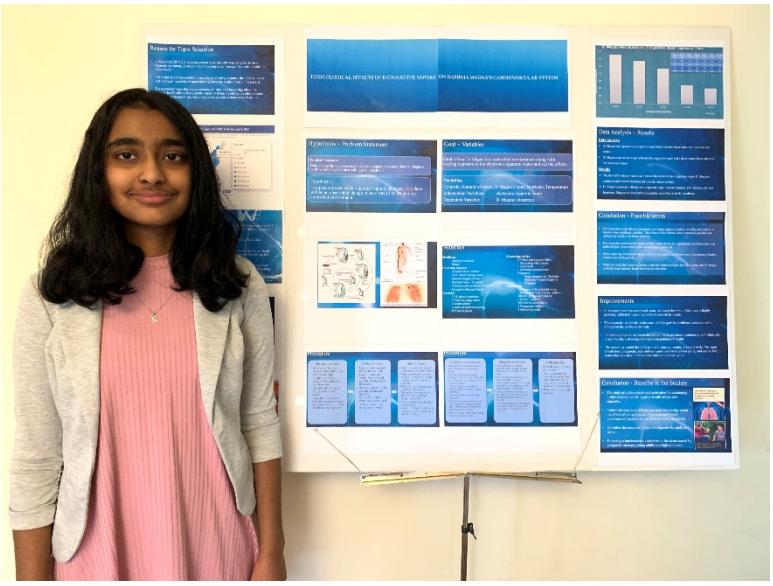


MEET THE 2020 DVSF GRADE 9 SILVER MEDALIST—Vrishti Yadav, Pennbrook Middle School. Vrishti worked on a *Smart Electronic Compression Glove for Arthritis Patients*.

Vrishti tells us about her personal connection to this project:

When I was in 3rd grade, I began going to the Delaware Valley Science Fair award ceremonies watching my brother receive his numerous, well-deserved awards. At first, I didn't give much thought about my future in the science fair, but as I got into 5th grade, many people started to encourage me to give science fair a chance. In 6th grade, I went to my first science fair and made it to DVSF. Ever since that day, I have been going to my local science fair and DVSF every year. When I was young, I was exposed to Electrical Engineering because my dad is an Electrical Engineer. I liked Electrical Engineering, but I always wanted to apply those concepts to something that would benefit humanity as well. Soon, I discovered the field of Biomedical Engineering, and I was immediately engrossed by it. I started to study illnesses that would affect humans and observed how they carried out their daily tasks. This led me to think about devices for diseases, which would allow those patients to have a better quality of life. Since 7th grade, I have fabricated multiple devices for illnesses such as blindness and Parkinsons. The inspiration for my project this year was my dad. My dad has suffered from Rheumatoid Arthritis(RA) for almost 10 years. Having RA means that you will feel unbearable pain in your finger joints, which cause your fingers to not be able to move as easily. This has caused him to not be able to do many of the things that he loves.

My project this year was an electronic compression glove for Arthritis patients. This glove, which I designed and fabricated, consisted of many materials but the material of most significance was the Nitinol wires. These wires were shaped into coils and wrapped around each finger. Driver boards were used to control the current that flowed into each Nitinol coil. Those coils would then heat up and tighten around the patient's fingers. This allows for maximum relief to the patients because along with compression the joints were also being heated in the process. I also designed and coded a touch screen controller which the patient would be able to use to control the glove. My final product was tested on my dad, an actual patient with Rheumatoid Arthritis, and he said that it did provide great relief to his aching hands. I hope that my past, current, and future projects will be able to help many people live their lives to the fullest without any limitations.



MEET THE 2020 DVSF GRADE 9 BRONZE MEDALIST—Aishwarya Suresh, Parkland High School. Her project looked at the *Toxicological effects of electronic cigarette vapors on Daphnia magna*.

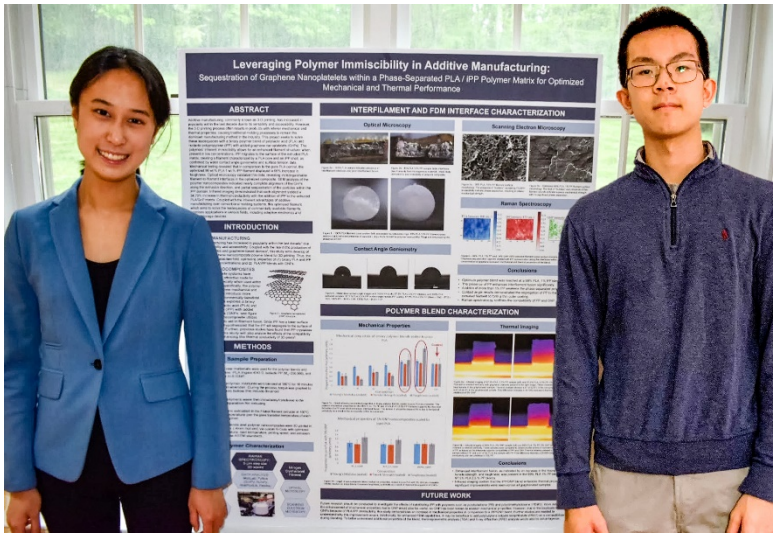
Aishwarya shares her story:

> In middle school, we all went through a program called D.A.R.E (Drug Abuse Resistance Education). It teaches the negative effects of drugs and alcohol. Nevertheless, when I first came to high school, I saw too many high school students vape frequently. This situation worried me and made me ask myself if I could fix things or at least educate my fellow peers. While researching for solutions, I learned from the CDC and other public health sources that the vaping epidemic is sweeping through numerous high school and middle school communities. The vaping industry claims that vaping is less harmful than conventional cigarettes, but it is marketed to first time users like teens and young adults.

I developed a website [www.missiontoday.org] to put together relevant information about vaping. I also thought the best way to reach out to my peers and educate them on negative health effects was to conduct an experiment to study it myself. My original plan was to test the toxicological health effects of electronic cigarette vapors on human bronchial epithelial cells. I reached out to labs and universities around the valley, but my project idea was not compatible with their lab settings. My project mentor and my sponsor recommended that I should use invertebrates.

Finally, I settled on the project Toxicological Effects of Electronic Cigarette Vapors on Daphnia Magna's Cardiovascular System. Daphnia Magna is an invertebrate; their body is enclosed by a transparent shell-like structure, one can see and count their heartbeats under a microscope. I was also able to count the clutch of eggs in their brood chamber. My desire for this project is for young teens to understand the negative health effect vaping has on their bodies and to avoid falling into the trap at a very young age.

Team Fair



MEET THE 2020 DVSF TEAM MEDALISTS—Addison Liu, Unionville High School, and Richard Li, Conestoga High School. Their project is *Leveraging Polymer Immiscibility in Additive Manufacturing: Sequestration of Graphene Nanoplatelets within a Phase-Separated PLA/iPP Polymer Matrix for Optimized Mechanical and Thermal Performance*.

Here are their perspectives on their work together in this project:

Addison:

The most memorable part of my time with this research project is undoubtedly my experience with the 3D printer. I spent hours every day in the lab, every day poking and

prodding at our Lulzbot printer, willing it to just extrude filament properly. Polypropylene and graphene nanoplatelets are two inherently tricky materials to print, and blending them certainly did not ease the difficulties. I would rewrite entire G-Code files only to find that the problem all along was a clogged extruder; I would go through dozens of versions of code just to get one set of parameters to work for a blend, only to find that the same parameters failed miserably for another blend. It was a continuous balancing act of adhesion sheets, bed temperature, nozzle temperature, and extrusion rate. At the time, the troubleshooting cycle seemed endless and, oftentimes, extremely frustrating; for a while in the middle of our research, Richard and I would return to our dorms every day absolutely drained and dejected (the summer heat and the lack of air conditioning definitely did not help our disposition).

Success finally came in the final weeks of our research internship; the elation that came with finally achieving our optimal blend made all my struggles with the Lulzbot seem insignificant. Yet, while these larger successes seemed to bring us the most fulfillment at the time, looking back, it is the small joys of our research that bring a smile to my face now; from our scrambling Starbucks runs to our mentor's birthday celebration, these happy moments are truly the ones that make me so passionate about our research.

Richard:

One aspect of our project that I appreciated was the large variety of technology we were exposed to. While many of the instruments we used provided much-needed testing data on our composites, some also just simplified and normalized processes for us. The importance of the enhanced efficiency these devices provided us became evident very early on in our research. When we first began our project, we did not yet have clearance to use the pelletizer, a device that ground our plastics into pellets so they could be extruded into filaments. Eager to get working on our project despite this temporary barrier, we began to "hand-pelletize" PLA filaments using a pair of wire-cutters. No more than 10 minutes into this process, our wrists began to feel like jello from the repetitive squeezing we had to do. Once we finally got access to the pelletizer, the daily clinking of the plastics in the device became a reminder of the time and wrist strain that it saved us from.

On the other side of things were the devices that helped us analyze our samples—the scanning electron microscope, tensile tester, thermal imaging device, contact goniometer, and many others. Each of these helped us determine more about our composites, and putting together the data from each device was almost like completing a jigsaw puzzle. As each aspect fell into place, we began to more clearly see the full picture and form a cohesive conclusion.

MEDALISTS' ABSTRACTS

Rishi Vaidyanath

Investigating Synthetic Compounds to Potentiate SMAC Mimetic Targeting Agent

The phrase "drug resistance" is often coined for bacteria's reluctance to die in the presence of antibiotics; however, viruses are often overlooked. The Hepatitis B virus (HBV) and its effect on cellular function has been a contested topic. Numerous studies have shown how HBV can lead to liver cancer: as the virus replicates, damaged DNA can activate pro survival genes that lead to death resistance. It is suggested that HBV infection encourages cell proliferation and resistance to cell death, which increases the odds of drug failure.

The first objective is confirming whether HBV infected cells resist stimulated cell death. To test this, SMAC Mimetic (LCL-161), a FDA approved drug that induces apoptosis was selected based on accessibility. A parental liver cell line, HEPG2, provided a control to the HEPG2 2.15 cell line which was infected with virus. First, numerous viability assays observed much more drug resistance with the infected cell line. In addition, a caspase assay which measures apoptotic death revealed a stark inhibition of death among the infected cell line. A western blot was also conducted to determine an increase in pro-survival genes among the infected cell line. Through this experiment, it was found that HBV infected cells do indeed resist stimulated cell death.

The second objective of this research aims to find an anti-inflammatory compound to enhance drug treatment on HBV infected cells. Preliminary data suggests that Desmethoxycurcumin and TNF-alpha act as the best drug enhancers with a 45% and 93% increase in cell death, respectively.

Ariel Baiano

Developing a Novel Non-Reliance Posture Trainer

Mainstream posture correction devices primarily consist of rigid braces or kyphotic slouch detectors. While these devices provide temporary solutions, they can cause anatomical reliance and improper bodily correction; Therefore, trainers currently available on the market are inadequate in their approach of correcting posture. The purpose of this project is to design an innovative long-term solution to poor posture. The novel design, entitled the Smart Wearable Automatic Posture Training Apparatus (SWAPTA), consists of a smart shirt activated by kyphotic slouch-sensing technology. Activation of the device involves physical shoulder girdle manipulation via muscle wire and electromyostimulation via a transcutaneous electrical nerve stimulation

(TENS) component. The vest is worn in tandem with a short stretching and exercise routine performed in accordance to device activation. The employment of static and physical correction aims to create an equilibrium between agonistic and antagonistic muscle groups, resulting in the dynamic balance required for fluid posture. The SWAPTA utilizes a more progressive and effective approach in posture correction than mainstream devices due to the creation of dynamic rather than static posture, strengthening the body rather than forcing correction, and establishing long-term independent correction. By introducing SWAPTA to the market, the public will have access to a progressive approach at solving the widespread problem of poor posture.

Christopher Gerhart
Fueling the Future

The reason why I chose my project, Fueling the Future, is because I wanted a project that involved electrical engineering that was applicable to the modern world. A reliable, renewable, and relatively clean fuel source is the next large step in technological advancements. The project design offers potential for multiple modifications, adding a level of complexity and the ability to adapt the design as needed. The overall engineering goal of the project is to design and fabricate a functional hydroxy / oxyhydrogen gas generator that can be modified to fit certain applications. The gas can be used as a fuel for engine combustion and as a fuel for burning. The electrolysis generator can be modified to separate the gases or to utilize different mixtures to yield different products, such as hydrogen and oxygen gas. Functionality is not the only goal: Efficiency, reliability, and safety are just as important. Different materials and methods will be utilized to find a cost effective prototype that can function as a strong foundation to several modifications to fit multiple uses.

Emily Wang
Wearable Lactate Sensor: Effective Biomarker Monitoring

Lactate is a biomarker checked through routine lab tests at doctor's visits or hospitals. High lactate levels indicate diseases like lactic acidosis and sepsis. Sepsis is the third leading cause of death and the most expensive in-hospitalization cost in the US due to longer stays in the ICU, extensive treatments, and readmissions. Currently, lactate tests require large blood samples from tourniquets or spinal taps, and the results are not efficiently given to patients, increasing risk for mortality. This research seeks to create a soft lactate sensor to improve the quality of life for patients who are at risk for or have sepsis and reduce the costs of hospital stays and treatments. A sticker or patch requires only microliters of fluid to record lactate concentration, making the detection process easier, immediate, and comfortable for the patient, allowing patients to monitor their health independently without constant surveillance by a healthcare professional. To achieve this goal, various prototypes of sensor housings are created using different fabrication methods and microfluidic channel designs.

Colorimetric paper assays treated with lactase and buffer within the silicone housing are used to detect the concentration of the biomarker. The effectiveness in detecting biomarker concentration is analyzed by measuring the color change and intensity from various concentrations of lactate with respect to the expected color change. This device could be used to more readily detect common diseases, decreasing mortality for patients whose diseases are undiagnosed, alerting the patient and the healthcare professional to act earlier and quickly to pursue treatment.

Benjamin Lin

Relative Tensile Strength of Starch-Based Bioplastics: Effective and Biodegradable Materials for Applications in Consumable Manufacturing

Plastic packaging contributes greatly to our carbon footprint. Many eco-friendly alternatives originate from renewable sources such as natural fibers or carbohydrates. Bioplastics not only reduce the depletion of fossil fuels, but these materials are also extremely biodegradable. This study investigates the tensile strengths of bioplastics from different starch sources and under different conditions to determine the optimal way of manufacturing bioplastic.

Six bioplastic sheets were made using water, vinegar, glycerol, and different starches. The sheets were cut into smaller pieces and tested for tensile strength using an Economy Force Sensor. Measurements for 10 samples for each of the 6 bioplastics were taken. There were 3 trials and 180 samples. The first trial included dry bioplastic pieces, the second and third trials tested the strengths of the pieces after 5 and 30 minutes of saturation in water respectively. Data was recorded and the tensile strength of the bioplastics was compared.

Conclusively, the study determined that:

1. There was a significant difference in strength (in N) between the different bioplastics.
2. Corn and green bean starch bioplastics withstood greater force compared to the other bioplastics.
3. Saturation in water significantly decreased all bioplastics' tensile strengths.
4. Bioplastics made from tapioca and potato starch had the weakest tensile strengths (before and after the water saturation tests).
5. Green bean starch-based bioplastic withstood the greatest force after saturation with water. Its clear and sturdy physical appearance make it ideal for manufacturing use.

Lillian Miller

Effects of Plastic Leachates on Various Organisms

Plastics are made with numerous additives that can alter the stability and nature of the polymer. These additives are often not chemically bound to the plastic polymer, allowing them to migrate within plastic. With increasingly large amounts of plastics and microplastics in our environment there is a need to better understand how additives in plastics leach from the polymer structure into the environment and its effect upon organisms. To this goal, a survey of common household plastics was undertaken to examine how plastic size and temperature contribute to leaching of compounds from various plastics and how the resultant leachate solution alters the viability and/or growth of Brine Shrimp and *Daphnia magna*. While no significant effect of leachates on the viability of Brine Shrimp were observed, leachates obtained from microplastic particles of polystyrene cup lids leached at 37ºC were extremely toxic *Daphnia.* This toxicity was not observed from leaching of larger pieces, or under different leaching conditions. Furthermore, the toxicity of the leachate was found to decrease with exposure to air, corresponding to a drop in the pH of the leachate solution and precipitation of a salt from solution. Studies examining the hatching of efficiency of Brine Shrimp demonstrated modestly lower hatching efficiency in the presence of several household plastics when degraded to microplastics and leached in the presence of heat, while no significant difference was observed for leachate solutions derived from larger plastics, or plastics leached at lower temperatures.

Olivia Takla

Using Machine Learning and Smart Insoles for Early Detection of Autism Spectrum Disorder

Over the last couple years, new research and studies have linked autism spectrum disorder (ASD) with abnormal gait patterns. Children with ASD tend to exacerbate their walking stability with a shorter stride length, increased step width and therefore wider base of support, and increased time in the stance phase. Other gait stereotypes children with ASD demonstrate include pacing, jumping, hopping, skipping, and spinning (restrictive and repetitive motor behavior). The most significant gait abnormality in those with autism is limited hip and ankle joint movement in children with ASD; this implies weakness around these joints, which is further exhibited by a reduction in ground reaction forces at toe-off in children with ASD. Several studies suggest that the cerebellar and basal ganglia are responsible for these irregular motor behaviors because of alterations in those areas of the brain. The purpose of this research project is to use the abnormal gait tendencies typically displayed by those with ASD in order to create an early detection system where the foot pressure distribution of a toddler is compared to the typical foot distribution of those diagnosed with ASD based on data collected in previous studies. A smart insole containing multiple pressure sensors was built to display and notify users of pressure readings and the correlation of these readings to the patterns commonly seen in those with autism. The smart insole detection system would allow non-specialized parents to detect ASD so that it can promote early intervention and also save costs of later detection handling.

Susan Deering
Designing a Prosthesis to Aid in Right Hand Motion of Violin

The purpose of this project is to create a body powered prosthesis that would allow a patient with a right wrist disarticulation or transradial amputation to perform basic violin bow technique, which was hypothesized to be possible. Examination of existing commercial and custom prostheses designed to accommodate a range of upper limb deficiencies revealed that none allowed the patient to effectively execute all essential aspects of basic bow technique. An effective assistive device for bow technique, as addressed in this project, must allow the patient to produce and manipulate a tone through manually applying weight and pressure to the bow and maintaining the bow parallel to the bridge for the entirety of the bow stroke. Both the motion of the bow and the tone created were evaluated.

The approach to design was to isolate functions of the bow and create a prototype that was mechanically and technically functional before developing a clinically viable prototype. The current prototype utilizes a pivot point, bow guide, and upper arm motion to maintain a parallel bow stroke; utilizes supination and pronation of the forearm to apply pressure; and allows weight to be applied to the bow. The user can produce a clear, pleasant tone and is able to include musicality mainly through changes in bow speed and pressure.

This project demonstrates that it is entirely possible for a patient with a wrist disarticulation or transradial amputation to perform violin bow technique using a body powered prosthesis.

Jen Parsons
Optimal Hair Bun Placement to Reduce Drag for Swimmers

This experiment was attempted to determine where the optimal hair bun location is located on a swimmer's head to reduce drag. There are three main types of drag a swimmer experiences while swimming. Pressure drag, this is due to the swimmer "pushing" the water out of the way as they swim. Friction resistance is due to the friction between the water and the swimmer's body as the water flows over it. Wave drag is drag due to the surface waves produced by the swimmer as he swims along. One of the most prominent ways to reduce drag was discovered when doing research for ships. The most effective bow of a ship for speed is called the bulbous bow. When this was tested, scientists concluded that it reduced resistance so much that it saved on the costs of fuel needed. Based on this research the hypothesis of this experiment is if the location of the bun is closer to the front of the head, then it will produce less drag. By moving the location of the bun on the mannequin's head and timing it when dragged through the water, the optimal bun location to reduce drag can be determined. When recorded, bun location one reduced drag the most, and bun location 2 reduced drag the least. The hypothesis was supported by the One-Way

Analysis of Variance (ANOVA) results. The results indicate that it is unlikely that the differences were random. The variation among the groups is more than expected by chance.

Lucy Wang

Assessing the Roles of Colitis-Associated Myofibroblast Cells

Colitis is the inflammatory disease condition in the inner lining of the colon, the key feature of inflammatory bowel disease (IBD), affecting over 1.3% of adults in the US. A significant cell profile change in the experimental murine colitis models is the loss of crypt epithelial cells and the appearance of a large amount of α-smooth muscle actin-positive fibroblast cells, referred to as colitis-associated myofibroblast (CAM) cells. But, how CAM cells contribute to inflammation, wound healing and tissue fibrosis remains unknown. This study hypothesizes that CAM cells are actively involved in colitis by responding to pro-inflammatory cytokines and expressing genes promoting inflammation and/or tissue repair. Using established mouse CAM cell line, this study demonstrated that CAM cells are responsive to pro-inflammatory cytokines TNFα, IL1β and IL6 but not IL11. By investigating the gene expression profile, this study provides the data suggesting that TNFα increases cell proliferation and mobility of CAM cells and modulates the cell-cell and cell-matrix interactions. More, TNFα induces the expression of IL6 in CAM cells, which may augment the existing inflammatory conditions and/or promote the proliferation of epithelial cells. Together, these findings provide preliminary evidence supporting that CAM cells could play critical roles in contributing to inflammation and repairing injured colon epithelium resulted from colitis. Such activities of CAM cells should be further investigated for a better understanding of the molecular and cellular mechanisms of colitis. CAM cells could also be the target for exploring the preventive and therapeutic approaches.

Vrishti Yadav

Smart Electronic Compression Glove for Arthritis Patients

In the United States alone, 54 million people are diagnosed with Arthritis. Out of those 54 million people, 2.1 million suffer from Rheumatoid Arthritis. Rheumatoid Arthritis is an autoimmune disease in which the body's immune system mistakenly attacks the body's joint instead of bacteria. RA affects the lining of your joints, causing a painful swelling that can eventually result in bone erosion and joint deformity. Rheumatoid Arthritis mainly affects the joints of hands, feet, wrists, elbows, knees, and ankles found in people between ages 30-50. Joint stiffness will decrease with movement but many patients are not able to move the affected area because of the painful swelling that occurs. This glove is designed to help relieve the pain and swelling experienced in the joints of Rheumatoid Arthritis patients. The glove will consist of a compression mechanism which is designed using Nitinol wire coils found

at each major finger joint. When a patient feels swelling or pain they will be able to initiate compression in the glove through a controller. When initialized the controller will send a meticulous amount of current through the wire causing the Nitinol wire coil to compress allowing for the pain and swelling to diminish. The Nitinol coil will get heated in the process allowing for the patient to get further relief in their joints. The controller will have a screen displaying a diagram of the human hand. The controller will have a touch screen interface to control the compression of each joint.

Aishwarya Suresh
Toxicological effects of electronic cigarette vapors on Daphnia magna

As per C.D.C, e-cigarette usage has reached epidemic proportions amongst teens and young adults. There is not much research done about the health effects of e-vapors on living organisms. There is a need for urgent research to study the adverse health effects of e-cigarette vapors. F.D.A and the U.S government is not able to effectively regulate the industry due to a lack of proper research and understanding about the product. The researcher hypothesizes that "If exposure to electronic-cigarette vapor is varied, then there will be an observable change in heart rate of Daphnia magna in a controlled environment."

The researcher studied the effects of the different exposure of e-vapors, on the heart rate in Daphnia magna. To test this, the researcher grew Daphnia magna in five 250 mL beakers, injected e-vapors daily for 40, 30, 20, 10 minutes in each beaker respectively, recorded heart rate of Daphnia magna using a dissecting microscope and stopwatch for five successive days. Five trials for each exposure to correctly test the hypothesis.

Daphnia magna exposed to e-cigarette vapors for an average of 40 minutes a day had a 15% drop in the heart rate compared to Daphnia magna unexposed to e-cigarette vapors. This shows that Daphnia magna exposed to e-cigarette vapors for extended periods adversely affects its cardiovascular activity. The study findings are in line with what the researcher had predicted based on prior scientific study on conventional tobacco products.

Addison Liu and Richard Li
Leveraging Polymer Immiscibility in Additive Manufacturing: Sequestration of Graphene Nanoplatelets within a Phase-Separated PLA/iPP Polymer Matrix for Optimized Mechanical and Thermal Performance

Additive manufacturing, commonly known as 3-D printing, has increased in popularity within the last decade due to its versatility and accessibility. However, the 3-D printing process often results in products with inferior mechanical and thermal

properties, causing traditional molding processes to remain the dominant manufacturing method in the industry. This project seeks to solve these inadequacies with a binary polymer blend of polylactic acid (PLA) and isotactic polypropylene (iPP) with added graphene nanoplatelets (GnPs). The polymers' inherent immiscibility allows for an enhanced filament structure: when present in low concentrations, iPP migrates to the surface of the extruded PLA matrix, creating a filament characterized by a PLA core and an iPP shell, as confirmed by water contact angle goniometry and surface tension data.

Mechanical testing revealed that in comparison to the pure PLA control, the optimized 99 wt.% PLA 1 wt.% iPP filament displayed a 66% increase in toughness. Optical microscopy validated this data, revealing indistinguishable filament-to-filament interfaces in the optimized composite.

SEM analysis of the polymer nanocomposites indicated nearly complete alignment of the GnPs along the extrusion direction, and partial sequestration of the particles within the iPP domain. Infrared imaging demonstrated that such alignment yielded a 34.79% increase in thermal conductivity with the addition of iPP to the extruded PLA/GnP matrix. Coupled with the inherent advantages of additive manufacturing over conventional molding systems, this optimized filament promises novel applications in customizable electronics and energy storage devices.