2021 FINALISTS

2021 Broadcom MASTERS

OCTOBER 22–28, 2021

Broadcom MASTERS® (**M**ath, **A**pplied **S**cience, **T**echnology and **E**ngineering for **R**ising **S**tars), a program of Society for Science, is the premier middle school science and engineering research competition in the United States.

In the only middle school STEM competition leveraged through Society-affiliated fairs, the top ten percent of 6th, 7th and 8th grade projects around the nation are nominated to compete in the 2021 Broadcom MASTERS. The Top 300 Broadcom MASTERS are selected by scientists and engineers through blind scoring of their comprehensive online applications.

From the Top 300, 30 finalists are selected to present their research projects in the virtual Broadcom MASTERS finals week, and compete in team STEM challenges that test their abilities in 21st Century skills — critical thinking, collaboration, communication and creativity — through project-based learning. Top awards reach more than $100,000, and include the Samueli Foundation Prize of $25,000, STEM summer camps and more.

Society for Science thanks the following for their support:

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- Society for Science's Affiliated State and Regional Science and Engineering Fairs
- Parents, teachers and mentors of all the Broadcom MASTERS nominees in ~300 fairs

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Why Middle School?

Broadcom MASTERS® is the premier science and engineering fair competition for middle schoolers, where students demonstrate their mastery of Math, Applied Science, Technology and Engineering as Rising Stars in STEM.

Participants in Broadcom MASTERS are inspired, mentored and encouraged to stay with math and science through high school and beyond so that they are prepared to pursue exciting STEM careers.

Students who participate in Broadcom MASTERS are better prepared through project-based learning to meet the challenges of the future as tomorrow's innovators. They will lead the way with scientific breakthroughs, engineering innovations and technological know-how.

Middle school students are invited to compete for awards and accolades in Broadcom MASTERS when competing at their local Society-affiliated science and engineering fair.

At the competition finals for Broadcom MASTERS, students can win cash prizes and experiential awards. The top winner is awarded the $25,000 Samueli Foundation Prize.

The Process

To participate in Broadcom MASTERS, 6th, 7th and 8th grade students enter an independent science or engineering project in their Society-affiliated state or regional science fair. Judges selecte the top 10 percent of these competitors to enter the Broadcom MASTERS, of which thousands are named each year.

Nominees go online to complete the comprehensive Broadcom MASTERS application and the entries are scored by scientists, engineers and evaluators during the summer.

The Society announces the Top 300 Broadcom MASTERS late summer each year. The Top 300 and their teachers receive an educational prize in recognition of their achievements.

Thirty competitors are selected from the Top 300 to compete as Broadcom MASTERS finalists. This year, finalists will participate in an online competition, showcasing their projects and competing in teams virtually to demonstrate their STEM acumen and 21st Century skills. They also visit historical sites in the nation's capital that celebrate innovation.

Awards

Finalists receive a cash award of $500 from Broadcom Foundation in recognition of their advancement to the Broadcom MASTERS finals. Based on their performance over three days of competition, finalists may receive top awards, including:

- Samueli Foundation Prize of $25,000, which recognizes the top middle school student among the 30 finalists who demonstrates mastery of science, technology, engineering and math. This finalist exemplifies how research, innovation and teamwork come together to achieve STEM goals.
- DoD STEM Talent Award of $10,000, awarded to a finalist who demonstrates excellence in science, technology, engineering or math, along with the leadership and technical skills necessary to excel in the 21st Century STEM workforce and build a better community for tomorrow.
- Marconi/Samueli Award for Innovation of $10,000. This finalist demonstrates both vision and promise as an innovator, and ideally, in the spirit of radio inventor Guglielmo Marconi, has applied concepts from electrical engineering.
- Robert Wood Johnson Foundation Award for Health Advancement of $10,000, which recognizes the student whose work and performance show the most promise in health-related fields, and demonstrates an understanding of the many social factors that affect the health of communities.
- Lemelson Award for Invention of $10,000, awarded to a young inventor who exemplifies the ideals of inventive thinking by addressing a critical societal problem in order to improve the lives of others. This finalist demonstrates the application of empathy, STEM knowledge, design thinking and an entrepreneurial mindset in the research and development of a tangible product.
- Broadcom Coding with Commitment Award of $5,000, awarded to a finalist whose project and performance combines expert STEM knowledge and passion for helping or improving one's community through computation/coding.
- First and second place awards for students in each STEM discipline for nearly $30,000 in experiential or product awards for their ability and promise in each of these disciplines, including top awards in math from Robert John Floe, President, Floe Financial Partners.
- Rising Star Awards are presented by Broadcom Foundation to two 6th or 7th grade finalists who exemplify great promise and will represent the United States as delegates to the Broadcom MASTERS International, which brings together middle school delegates from around the world at the Regeneron International Science and Engineering Fair in May 2022.
- The Broadcom Leadership Award is bestowed upon the Broadcom MASTERS finalist elected by his or her peers to speak on behalf of their class at the Awards Ceremony. The Class Speaker demonstrates the collegiality and spirited leadership that has earned the collective esteem of the class throughout the Broadcom MASTERS competition and united them around common goals.
- The Top 300 Broadcom MASTERS receive special recognition through a gift from Jeff Glassman, CEO, Covington Capital Management.

Awards Honoring Finalists' Schools and Teachers

Broadcom Foundation and the Society recognize the important contributions of the teachers who educate, mentor and support Broadcom MASTERS competitors by awarding a gift of $1,000 to each of the 30 finalists' schools to be used for STEM programs and a digital classroom subscription to *Science News* magazine.

ARJUN AGARWAL

Portland, Oregon | Age: 14

A Machine Learning-Based Innovative Approach for Early Detection and Forecasting of Harmful Algal Blooms (HABs)

Project Background: Harmful algal blooms (HABs) in water can kill fish, sicken people and close beaches. Arjun was motivated to investigate HABs after a health advisory warning stopped him from visiting a Florida beach during a family vacation. He learned that increased global warming and pollution have caused HABs to become more of a problem, at great cost to the U.S. economy. Current forecasting based on satellite images only addresses 0.6% of all U.S. water bodies. Arjun therefore decided to use machine learning to analyze the huge amount of data already being collected by automated sensors and buoys and predict the development of HABs.

Tactics and Results: Arjun found that current state-of-the-art models from the National Oceanic and Atmospheric Administration (NOAA) use supercomputers, satellite images and water current statistics to predict HAB development four days in the future. To extend that, Arjun developed a machine learning model on his home computer using publicly available water quality data and tested the effects of each variable being collected. He found that using statistical markers instead of the raw data improved his forecasts. Arjun's four-day predictions were about as accurate as those of the NOAA, but he could extend the forecasting range up to seven days with an accuracy of 86%. In addition, Arjun believes his model could be applied nationwide, though it would likely have to be modified to include data from sites where sewage and fertilizer runoff are major contributors to HABs.

Other Interests: Arjun enjoys playing chess, the piano, badminton and swimming, as well as participating in math competitions. He is also an avid fan of the comic strip Calvin and Hobbes. He intends to become a computer scientist so he can pursue his dual interests in math and problem solving.

SEBASTIAN RAE ALEXIS

Irvine, California | Age: 13

Quantifying the Effectiveness of Lockdown Measures Using Effective Reproduction Number (Rt) of SARS-CoV2

Project Background: California's COVID-19 safety measures called for a lockdown, but sparked protests by those who argued that they were not effective and were pointless. Sebastian, often called Sebe, decided to search for scientific evidence to see if the county lockdown was working. After doing research, he "stumbled upon" a mathematical model using an "effective reproduction number (R)." Its starting point measures the initial rate of virus spread in the population and then changes as time passes and the virus does or does not reproduce.

Tactics and Results: Sebe started with the assumption that a lockdown would change COVID's rate of contact and transmission. He set out to calculate the lockdown's effectiveness using a virus-spread model that has four component populations: people who are susceptible, exposed, infectious or recovered. Starting with the initially documented value of R for the Orange County, Sebe tracked the R value over time as the state lockdown continued. His results showed that during the early stages of the COVID-19 outbreak, the first R value in the county was high (3.22). This indicates a significant virus presence. However, after state-level safety measures had been taken, the reproduction number decreased significantly to 0.67. He says that the reduction demonstrated the benefits of limiting mobility and that the lockdown successfully slowed the spread of COVID in his part of Southern California.

Other Interests: Sebe is a figure skater and enjoys roller hockey. He hopes to continue studying behavioral science so he can further explore the workings of the human mind, consciousness and instincts. He says much remains unknown and needs more research.

JUDY ELIANA BAI

Ann Arbor, Michigan | Age: 13

Computational Prediction of COVID-19 Risky Genes Associated with Lung Cancer

Project Background: Judy's research has been strongly influenced by natural inquisitiveness and her parents' careers. Her father is a genetics researcher, and her mother works with elderly patients with lung diseases like cancer. After Judy learned that several of her mother's patients died from COVID-19, she wanted to know why. Could there be genes associated with lung cancer that were also targets for COVID-19? Building on her love of math and her strong computer skills, she was motivated to find the answer by analyzing currently available databases, an area of science called bioinformatics.

Tactics and Results: By reading prior research, Judy learned that genes are often expressed at different levels in people with medical conditions. This means that diseased cells, like cancer cells, make more or less of a gene than a healthy cell. This leaves them unable to react to invaders like a coronavirus. She then theorized that genes that are expressed differently in lung cancer should have the same expression in COVID-19 cases. For her research, Judy downloaded lung cancer data from a national database. She then identified down-regulated genes, which means the cell is making less of one of its components, such as a protein. She then ran a series of computer analyses of protein interactions and patient survival rates. She found that genes that are down-regulated in lung cancer are also under expressed in COVID-19 cases. She concluded that these genes contribute to the co-occurrence of lung cancer and coronavirus diseases. In the future, she hopes to use machine learning to find more genes associated with both conditions.

Other Interests: Judy loves to bake and says the concentration that baking requires is like meditation and helps her relax. A multi-sport athlete, she admits that figure skating and gymnastics are her favorites. Her career goal is to become a physician and to save lives by ensuring that her patients get the best possible medical care.

CLARA CHOI

Santa Ana, California | Age: 14

EEG Study of Virtual Learning Demonstrates Worsened Learning Outcomes and Higher Mirror Neuron Activation

Project Background: Clara's dream came true when she was accepted into the intensive training program at the San Francisco Ballet School, which was taught online because of the pandemic. To her surprise, she found it difficult to learn the choreography. So, Clara, who is also interested in neuroscience, decided to find out if the brain might react differently to virtual and in-person learning. She read an article about ballet dancers and mirror neurons, which are brain cells that react when a particular action is performed and also when it is only observed. She then decided to study if the activation of mirror neurons differed in virtual and in-person dance training.

Tactics and Results: Clara theorized that there would be lower levels of neuron activity during virtual training, which would result in poorer learning outcomes. To measure neuron activity, she used a special headset that tracked waves from the area of the brain where mirror neurons are present. Then she enlisted eight study participants who had their brain waves recorded while sitting and watching a dance teacher demonstrate two different routines, one in person and one that was recorded. Each was then asked to perform the routines and was scored based on how well they did. When Clara analyzed her data, she found that the participants scored significantly worse after the virtual dance lessons, supporting her theory. But her hypothesis about neuron activity was incorrect. Neuron activity was not suppressed during virtual training. It was significantly higher, perhaps due to the added mental exertion required.

Other Interests: Clara is a competitive dancer who began training at age two. She studies hip hop, jazz, ballroom, contemporary and tap, and is part of a pre-professional ballet company. Clara hopes to become a neuroscientist and pursue her interest in the neuroplasticity of the brain and restoring brain function.

RYKA C. CHOPRA

Fremont, California | Age: 13

Does the Tail Wag the Dog, After All? Obesity Clusters & Their Influence on Predatory Location Choice of New Fast-Food Chain Franchisees

Project Background: Obesity is currently the second leading cause of preventable death in the United States, with the National Institutes of Health attributing about 300,000 annual fatalities to obesity related diseases. Consumer research has established a strong link between eating fast foods and obesity. After Ryka watched a documentary on this subject, she decided to investigate whether or not the business practices of fast-food chains are to open new restaurants in areas that already have relatively high obesity rates, thereby increasing the availability of fast food to vulnerable populations.

Tactics and Results: Ryka used data about fast-food branches across 2,017 U.S. counties and compared it to obesity data from 2016-2017. She started by geocoding fast-food locations and clusters of obese people. She measured a mean obesity rate of 28.7% in her sample and discovered that for every 1% increase in the obesity rate of a cluster, 2.7 new fast-food branches opened within a two-mile radius of the cluster in 2019-2020. She observed that the highest concentrations of new branches were located within a radius of 1.5 to 2 miles from an obesity cluster, gradually diminishing beyond a three-mile range. Based on her research, Ryka wonders if a close proximity to obesity clusters reveals a business intention to locate new fast-food restaurants nearby.

Other Interests: Ryka is an avid violist and pianist who realized a childhood dream when she gave a solo Rachmaninoff performance at Carnegie Hall in New York City. She enjoys Science Bowl and Student Council and volunteers at an elderly care center.

KATHERINE GILCHRIST

Orefield, Pennsylvania | Age: 13

Dress for Success: Which Fabric Drapes Best?

Project Background: Kate's love of fashion and fabrics inspired her research. Textiles, which are woven fabrics, are used for many purposes because when they are laid over another object, they conform roughly to the shape of the object. However, a fabric's exact bending and folding, known as drape, depends on the fabric's characteristics, including its weight, size and flexibility. How a fabric drapes can be important for many uses, such as foldable solar panels. Kate hoped to find out if a draped piece of fabric would have a predictable area and number of folds as it increased in size.

Tactics and Results: Kate tested six types of fabric: cotton, tulle, twill, satin, flannel and fleece — all with very different weights and densities. She cut each type into circles of increasing size and lifted each one from its center using a fishing rod and hook to simulate draping. She measured the area of each piece both before and after it had been draped, and then she counted the number of folds that had formed in the fabric. She used image analysis software to determine the change in the fabric's relative area when flat and then when draped. She found that when she increased the radius of a fabric circle, more folds formed when it was draped, reaching a maximum number of folds when the circles reached a certain size. Kate correlated the number of folds with the density of the fabric and says her work provides a predictive tool for those making choices for clothing or other products that use fabrics, such as solar panels and parachutes.

Other Interests: Kate studies German, Spanish and French and plays piano, cello, saxophone and clarinet. She also enjoys robotics and the art club. She hopes to become a fashion designer one day.

EAMON GORDON

Goleta, California | Age: 14

Assessing the Effect of Voice Onset Time on the Perception of English Consonants

Project Background: For humans to make the sound of a consonant while speaking, their body must perform a two-step process. First, the speaker has to close or constrict the mouth. For many consonants, this causes pressure to build in the vocal tract. Shortly after that, the speaker opens the mouth, but before the vocal cords can begin to vibrate and produce the sound of the following vowel, the pressure in the vocal tract must decrease. This brief period of time, between the release of the mouth's constriction to pronounce the consonant and the production of the following vowel, is referred to as Voice Onset Time (VOT), the subject of Eamon's research.

Tactics and Results: Eamon recruited subjects to test whether changing the length of the VOT affected their perception of consonants in the English language. He used two pairs of words, "tab" and "dab," and "tad" and "dad," that are spelled differently but begin with consonants that differ in only subtle ways. He then met with subjects, a task complicated by COVID-19 restrictions, and played recordings of the test words but varied the VOT from 6 milliseconds to a maximum of 56 milliseconds to judge its effect on the perception of consonants. When he surveyed his junior high school subjects, his results showed that they shifted their perception of the words as Eamon lengthened the VOT past a certain threshold. For example, the survey responders began to perceive "tab" instead of "dab." The findings of Eamon's project suggest that VOT is critical when young people, including those who are multilingual, attempt to distinguish between similar sounds in English.

Other Interests: Eamon created a mineralogy website saying it allowed him to combine his appreciation for mineralogical beauty and website design. He hopes to become an economist because the subject involves two of his passions, mathematics and finance.

CHARLES HENRY GORMAN

Chula Vista, California | Age: 13

Pump & Circumstance

Project Background: Charles, who goes by his nickname, Chip, embarked on this project to appease a disgruntled neighbor who was bothered by the noise of the pool pump located behind Chip's new family home. Even though the noise was within city requirements, Chip decided to design and build a casing to go over the pool pump to muffle the noise and stop it from being a nuisance to his neighbor. He tested four lining materials – bubble wrap, corrugated cardboard, Styrofoam and carpet – to see which one absorbed the sound the best.

Tactics and Results: Chip's hypothesis was that of the four materials he tested, the carpet lining would lower the decibel reading the most. But before he could experiment, he had to design and construct an enclosure that could withstand the elements, allowed easy access to the filter for cleaning and did not obstruct the airflow that prevents the motor from overheating. Chip built prototypes with posterboard and foam board before measuring and cutting the plywood and assembling the box with hinges. He used glue to line the interior of the box with each material and then tested the noise from his neighbor's backyard using a handheld digital sound level meter. His data showed that his hypothesis was correct – the carpet absorbed the sound best, followed by the cardboard, bubble wrap and, lastly, the Styrofoam.

Other Interests: Chip enjoys animating, swimming, video games and reading. He also plays the piano and is an altar server at his church. Chip hopes to become a software developer because he believes that he can create video games with better storylines.

SOHAN GOVINDARAJU

Portland, Oregon | Age: 13

A Novel Mathematical Approach to Predict the Spread of a Wildfire Using the SIR-based Model

Project Background: In 2020, Sohan's home state of Oregon was plagued by forest fires while at the same time, the COVID-19 pandemic was raging around the world. Sohan realized that although they are very different in nature, forest fires and epidemics have a lot in common. They both have a central point of origin, spread outwards and can get exponentially larger over time. Sohan wondered if these similarities meant that a type of mathematical model, referred to as an SIR model, that is commonly used to predict the proliferation of diseases could be adapted to forecast the spread of wildfires, with the burning trees taking on the role of sick individuals.

Tactics and Results: Sohan created his model using publicly available data for two Oregon forest fires. He assumed that all burning areas were equally important in evaluating fire intensity and added two independent variables to incorporate aspects that would cause the fires to increase in size (factors such as wind speed) or decrease in size (measures taken to control the fire). Sohan manually updated the daily values for trees that were susceptible, burning or burned and then adjusted the values of the independent variables until the results were similar to what had actually occurred. He then explored a scenario in which the first responders had reacted more quickly to the forecast of increasing wind speed and began containment measures a day sooner than they did. His model indicated that overall fire intensity would have been reduced by 50%, which suggests that using SIR models along with meteorological forecasts could be useful for wildfire management.

Other Interests: Sohan has a passion for robotics and is a big sports fan. He has also helped illustrate children's books for a non-profit organization in India that teaches English to tribal children there. He has taught chess, science, and math to elementary school students and greatly looks forward to becoming a science teacher.

GABRIELA GUERRA SANCHEZ

Waco, Texas | Age: 13

Can You Hear That? What Do You See?

Project Background: The inspiration for Gaby's research arose from something she noticed about herself: listening to music on her headphones had a profound effect on how she saw her surroundings. When the style of music changed, so did her perception of the world around her. She wanted to know if others were affected the same way. As a painter, Gaby also wondered how music might affect the way people see art. She believed that it would. To find out, she decided to do research based on the hypothesis that changing the background music at an art installation would change the perspective of the viewer.

Tactics and Results: The data for Gaby's research came from responses to a survey filled out by students after listening to music and viewing an original abstract painting that Gaby created. The background music was five popular songs that evoked different moods. Because she was an at-home learner, Gaby depended on her teacher to run the experiment. The teacher would show the painting, play one of the songs, and have the students fill out the survey. Data was gathered over six days, five with music and one without. When she analyzed the data, Gaby found that 57.8 percent of the time, a student's perspective changed while listening to the music, and that it changed the most on the first day and the least on the day no music was played. She believes her work could lead to more appropriate music choices for stores, restaurants and hospitals.

Other Interests: In addition to drawing and painting, Gaby has been learning to play the electric guitar. She is also learning to box, which gives her a good workout and quality time with her father. A lover of mystery and crime shows who likes solving puzzles, Gaby is leaning towards becoming a forensic scientist.

ANNELIESE HSIAO

Plantation, Florida | Age: 13

The Effect of a Hot Car Interior on Hand Sanitizer Alcohol Content

Project Background: Anneliese noticed that the hand sanitizer pump dispenser in her family's car had been dripping and wondered if alcohol might be escaping due to the intense heat of the car's interior. In Florida, the interior of an unshaded car can reach up to 80° Celsius (176° Fahrenheit). She learned that hand sanitizers should contain at least 60% alcohol to be effective and decided to determine if hand sanitizers were still effective after prolonged exposure to high temperatures. Anneliese heated sanitizers in various containers (plastic, pump, and spray bottles and flip cans) in an oven at 80° Celsius. Her control group included similar bottles containing water or 99% isopropyl alcohol and bottles at room temperature.

Tactics and Results: Anneliese determined the approximate alcohol content of each container using a hydrometer. She found that open or loosely capped bottles lost the most alcohol by evaporation; the hand sanitizer in these bottles became ineffective because the alcohol dropped to as low as 28.3%, well below the recommended 60%. Pump bottles lost a lot of liquid due to dripping from the spout and warpage of the bottles, and the alcohol content decreased somewhat in these. Spray and flip cap bottles had a minimal loss of volume or alcohol content. Most importantly, the results showed that if hand sanitizer bottles are left without a secure cap in a hot car for about two weeks or longer, they may no longer be effective at killing germs and should be replaced.

Other Interests: Anneliese is very proud of having won the Florida Federation of Music Clubs Piano Concerto competition — twice! She also enjoys dancing and spending time with animals as a Humane Society volunteer. Her deep love of animals has led her to plan to become a veterinarian.

LUCAS KATZ

Moraga, California | Age: 14

Underwater Wireless Transmission of Data and Energy Between an Underwater Robot and a Floating Base-Station

Project Background: Lucas was inspired to work on this project by watching two videos. In the first, a man had wired a flashlight to an audio jack cable and a solar panel to a speaker, and then used the beam of the flashlight to transmit and play music. The second video, which was about unmanned-underwater-vehicles (UUVs) searching for a plane wreck, indicated that the UUVs had to be picked up frequently to be charged and have their data downloaded. Combining the two concepts, Lucas reasoned, it should be possible to send energy and retrieve data using a floating, light-powered base-station.

Tactics and Results: Lucas investigated the viability of using artificial light for underwater wireless communication and energy transmission. He researched underwater transmission using different wavelengths of visible light and the possibility of using photovoltaic cells to transmit data and energy underwater. Based on his studies, he designed and built a prototype underwater system to demonstrate this technology. The system included an underwater vehicle mockup and a base station equipped with remotely controlled photocells and LEDs that he built and tested. He used a high-power LED to transmit data as well as light from the base station to a solar cell to charge the UUV's battery. Lucas hopes that this concept might help Seabed 2030, an international project that is mapping the ocean floor using unmanned floats and vehicles, by providing an easier way to transfer both energy and data.

Other Interests: Lucas is a mountain biker and hiker, and likes to cook, play basketball and box. He also enjoys weightlifting and playing the guitar. Lucas would like to someday become a mechatronics engineer and a technology entrepreneur.

ATREYA MANASWI

Orlando, Florida | Age: 15

Finding the Best Novel, Safe, and Organic Treatment to Attract Small Hive Beetles and Improve Honey Bee Strength (Year 2 Study)

Project Background: Two years ago, while fishing with a friend and the friend's grandfather, Atreya learned about the plight of the honeybee. Tearfully, the 80-year-old beekeeper told him about the dramatic decline of honeybees and honey production. Committed to helping, Atreya became more dedicated to finding a solution to honeybee death when he learned that bees pollinate 80% of all crops and that their decreasing numbers could affect food production worldwide. He began his research last year at the University of Florida where he studied whether protein supplements could boost bee immunity and improve their health.

Tactics and Results: Atreya focused on the small hive beetle, a predator from Africa first found in Florida 20 years ago. In large numbers, the beetles can cause bees to abandon their hives. He learned that there are two in-hive ways to get rid of the beetles; to trap them or to poison them with a chemical, which requires extreme care to protect the bees and the beekeeper. Atreya preferred the organic trap approach. So, he tested apple cider vinegar (the currently used organic option), mango puree, cantaloupe puree, active dry yeast, peanut oil, dry grape seed and beer, with an empty trap as a control. Each attractant was tested at three hives. Every week for six weeks, he collected trapped beetles and counted them in his kitchen lab. He found that the beer was 33 times more effective than the vinegar. The USDA has granted funding for him to conduct additional research on this approach next year.

Other Interests: Atreya, who holds a second-degree black belt in Taekwondo, also enjoys fencing for "the adrenaline rush that comes with a swift defense or powerful attack." Interested in the interaction of living things and their ecosystems, he hopes to change the world in "great ways" by pursuing a career in biology.

VIHAAN PALIWAL

Hillsboro, Oregon | Age: 12

Don't Drive That Way, Have Another Day!

Project Background: More than 3,000 people die from distracted driving each year. After his family car was hit at a stoplight by a young driver who was using a cell phone, Vihaan decided to research the subject. He found that sometimes passengers were not even aware that their lives were in danger because the driver of the car they were riding in was distracted or drunk. (Drunk driving is even more dangerous, causing over 10,000 death every year.) Thus inspired, Vihaan set out to build a system that would warn everyone in the vehicle if the driver was distracted or drunk.

Tactics and Results: First, Vihaan designed and built a small system that senses whether the driver is holding the steering wheel with both hands and sounds an alarm if the driver removes a hand for too long, something a driver would do when distracted. After testing various materials, he built his system using touch sensors on the steering wheel and a small computer. Then Vihaan added a second module to his system to detect drunk driving. To do so, he installed two alcohol detection sensors in the car. In experiments, his prototype successfully detected air alcohol concentrations of 1% to 95%, and with a small modification to the steering wheel sensor, it achieved 100% in tests, especially at lower concentrations. He calls his simple and affordable prototype the Wheel-Integrated-Risk-Elimination (WIRE) system and says it can easily be installed in existing cars.

Other Interests: Vihaan is a big Baltimore Ravens football fan and can probably answer any question about the team. He also loves to play soccer year-round, rain or shine. He especially enjoys those days when his soccer team works together to play their best games. In the years ahead, he wants to pursue a career in science.

AVI PATEL

Fair Lawn, New Jersey | Age: 12

The B2B System for the Visually Impaired

Project Background: There are 12 million visually impaired people living in the U.S. and many of them would love to ride a bike, but they have limited options. For many, the only option is to ride on a tandem bicycle but doing so lacks the independence that brings joy to sighted bikers. Traditional biking systems for people with visual disabilities have involved a leash or attachment of some kind, but Avi and his teammate Ansh Sehgal made an electronic system that would discard the leash, allowing even sightless bikers to ride independently and confidently in a way that is safe, reliable and inexpensive – with no strings attached.

Tactics and Results: Avi's system requires two bikes: a pilot bike and a second that is unattached and receives instructions for steering safely. Someone with good eyesight rides the pilot bike ahead of the visually impaired person. Both bicycles have electronic components that allow the rider to proceed using electronic instructions received from the pilot. The system includes a gyroscope, a GPS and a radio frequency device that continuously transmit instructions to the guided cyclist. Multiple rounds of testing showed improvements with each version of the system. With modifications, guidance delay time dropped from 5.25 seconds, to 3.0 seconds, to 0.85 seconds. However, the current delay is still too long for safety reasons and a few more tweaks will be needed before the system is ready for real-life use. He plans to continue improving it, but currently, the entire system for both bikes only costs about $60.

Other Interests: Avi is an avid hiker and enjoys soccer. At school, he is a member of the art club and robotics club. He hopes to become a lawyer one day and specialize in technology issues so he can continue to pursue his current passions.

SAMHITA POKKUNURI

Old Bridge, New Jersey | Age: 14

A Novel Graph Neural Network for De Novo Drug Discovery: A Case Study on Glioblastoma

Project Background: Discovery of new drugs can take many years of research and cost billions of dollars. A key step in the process is finding an effective drug-target combination so the new drug can perfectly bind to a target on the protein. Current methods to predict drug-target interaction (DTI) involve finding the best part of the target protein for the drug molecule to bind with. However, not all targets have the 3D protein structures that allow this. A different way to predict DTI is by using machine learning systems, but current drug discovery methods that use that software can struggle to address protein-protein and drug-drug associations.

Tactics and Results: Samhita used a different type of neural network (a computer system modeled on the human brain and nervous system) that contains flexible, virtual connections (hypernodes) rather than those used in traditional machine learning systems. These hypernodes can "learn" to accurately predict drug-protein interactions. Using a publicly accessible database of already measured binding affinities, Samhita trained her model using 80% of the available data and tested it with the other 20%. She then used her model to search for drug-target interactions for glioblastoma, a cancer of the nervous system. Her machine learning model performed very well, finding 17 drug targets, of which two have already been approved by the FDA for the treatment of glioblastoma. This was a 15% improvement over the performance of existing machine learning models. She believes that her model can be used to help speed new drug discovery.

Other Interests: Samhita plays the violin, runs cross-country and track, and competes with a robotics team. She also enjoys performing the classical Indian Kuchipudi dance. She harbors an "unparalleled passion" for computer science, which will allow her to keep applying technology to help solve real-world problems.

NIPUN RAJAN

Germantown, Tennessee | Age: 13

Personalizing Masks for Optimal Results Using Computer Algorithms

Project Background: When Nipun learned that his elderly grandmother had trouble breathing through the N95 mask that COVID-19 has made a part of daily living for his family, he decided to do something about it. Through research, Nipun found that masks are not only a problem for the elderly; they can make breathing difficult for anyone with limited lung capacity. This can include very young children, pregnant women and people suffering from asthma and other breathing disorders. Would it be possible, he questioned, to custom-design masks to meet the specific needs of the wearer and adequately filter out coronaviruses?

Tactics and Results: Nipun designed his own test equipment and wrote the algorithms for his research. To test different mask materials, he sprayed water through the fabric into a black box where the droplets were illuminated with a laser and the brightness recorded using a homemade luminometer: the brighter the image, the less effective the filter. He determined the effect of social distancing by spraying the droplets from different distances. To find out if people with reduced lung capacity could breathe through the different materials, Nipun designed a peak flow meter modeled after a device used to test lung function and set a bicycle pump at different pressures to represent different lung capacities. After analyzing his data, he found that thicker masks were more effective than thinner ones, but that social distancing could improve the efficacy of thinner masks. He also found that effective masks could be customized for people with limited lung function.

Other Interests: Nipun is a violinist who enjoys reading history and hiking in the outdoors. But his real passion is studying the subjects he loves the most, like anatomy and physiology, heredity and epidemiology. Motivated by the doctors who are in the forefront of fighting the pandemic, he hopes to become a physician.

ELIZABETH REILLY

San Antonio, Texas | Age: 14

The Role of Leech Saliva and Shisho in the Inflammation and Healing of Diabetic Wounds

Project Background: Lizzie has witnessed first-hand the ravages of diabetes mellitus, a metabolic disease that results in dangerously high levels of glucose (sugar) in the blood. Her grandfather suffers from the disease, which has affected his vision and memory, led to a stroke and causes him to suffer with wounds that do not heal. Keenly interested in medicine, Lizzie decided to study the complex problem of wound healing and she chose to focus her research on two mechanisms that could positively affect healing: reducing inflammation and improving circulation at the wound site.

Tactics and Results: The objective of Lizzie's study was two-fold: to see if shisho, an herb known to decrease inflammation, and leech saliva, an anti-coagulant that reduces blood clots and improves circulation, could enhance wound healing and tissue regeneration in diabetics. She tested her theory on diabetic and non-diabetic planaria, a flatworm known for its ability to regenerate. To create a diabetic model, Lizzie exposed her flatworms to a sucrose solution for five days. She then cut some of them in two and treated them with either shisho, leech saliva or a combination of both. Some she left untreated as a control. She observed and measured the flatworms daily for 20 days and found that shisho and leech saliva used alone significantly improved their regeneration rate, but that the combination of both worked even better. Based on her research, she believes that an ointment made of a mixture of shisho and leech saliva could improve wound healing in diabetics.

Other Interests: Topping Lizzie's list of things she enjoys are science club, gymnastics, which she has practiced since she was three, and pole vaulting because it connects with her gymnastics training. From the moment she could speak, Lizzie has dreamed about becoming a physician, specifically a pediatric surgeon.

AKILAN SANKARAN

Albuquerque, New Mexico | Age: 14

On the Exploration and Analysis of Highly Divisible Numbers

Project Background: Akilan, who enjoys mathematics, decided to do a project on highly divisible numbers, also known as "antiprimes," which have been studied by numerous researchers dating back to Plato. Many people are familiar with prime numbers, which are only divisible by themselves and the number one. However, antiprimes can be divided by more numbers than any of the numbers that are smaller than it.

Tactics and Results: In recent years, mathematicians began differentiating antiprime numbers by how "smooth" they were. Antiprimes that contained fewer prime numbers among their divisors are considered smoother. Akilan decided to investigate how to expand the number of smooth antiprime numbers. He analyzed the techniques used to discover larger and larger antiprime numbers, and then used that information to create a new class of functions — the smooth class — to measure a number's smoothness and divisibility. His detailed analysis enabled him to find a formula that characterized the superior record-setters (the most highly divisible numbers). With this formula, he wrote a computer program that can efficiently and quickly calculate smooth antiprimes that are more than 1,000 digits long.

Other Interests: Akilan won first place in the 2018 Jackie McGehee Young Artists Competition for his piano concerto. He also likes playing the flute and drums. He hopes to become an astrophysicist so that he can merge three of his favorite topics: physics, mathematics and space science.

JOSEPHINE E. SCHULTZ

San Antonio, Texas | Age: 14

Effect of Light Pollution on Chrysalis Stage of Painted Lady Butterfly

Project Background: As a reward for selling Girl Scout cookies, Josephine, who goes by Jo, obtained a butterfly garden set that included five caterpillars of the painted lady butterfly. Knowing that hours of daylight affect insect behaviors and their biological clocks, Jo wondered if the brighter-than-normal night sky around her Texas home might affect how and when the caterpillars transformed into butterflies. This inspired her to acquire more caterpillars so that she could study how extended light cycles might affect butterfly metamorphosis.

Tactics and Results: To measure the effect of light pollution on the life cycle of painted lady butterflies, Jo randomly assigned her 40 caterpillars to one of four groups and exposed them to different light cycles, ranging from total light to almost complete darkness, including light cycles based on the seasonal natural light shifts in San Antonio. The insects in the group receiving the most light were the first to form a chrysalis (the hard protective case a caterpillar creates so that it can become a butterfly). The group that had only 9.5 hours of light per day formed their chrysalises last, 1.5 days after the fastest group. Later, the group that had received 24 hours of light was the first to emerge as butterflies, and they did so almost two days before the last group. Interestingly, the no-light group was the second fastest. Jo was concerned that these changes might cause butterflies to miss the crucial flowering time of some plants.

Other Interests: Jo is a Girl Scout and volunteers at the Animal Defense League of Texas. She enjoys painting, reading, swimming and music — she plays the piano, violin and guitar. Jo hopes to become an environmental engineer and to help solve problems such as global warming, pollution and habitat loss.

ANSH SEHGAL

Fair Lawn, New Jersey | Age: 12

Bike to Bike System for Visually Impaired

Project Background: A seed was sown in Ansh's mind by an experience he had while working at a school for the visually impaired in India. A young blind girl, hearing a milkman ringing the bell on his delivery bike, asked, in Hindi, "Did you bring your bicycle today? Can I ride?" That seed grew into an idea when Ansh met a friend who had a similar experience. Together they set out to help visually impaired people, who have a 21.3% chance of being obese, become more physically active. A survey reporting that bicycle riding, which is usually on a tandem, is the preferred exercise for the visually impaired, provided the final impetus for their project.

Tactics and Results: To give visually impaired riders a greater sense of freedom, Ansh and his partner, Avi Patel, designed a guided bicycle that wirelessly received instructions from a pilot bike. Because he loves coding, Ansh built and programmed a module that transmits yaw angle and GPS coordinates from the pilot bike. The guided bike has three modules: a data receiver, a mechanical clicker and a safety module. The data receiver converts the yaw angle and GPS data into voice instructions telling the rider what direction and how many degrees to turn. The clicker tells the rider how many degrees they are turning, with each click representing 15 degrees. The safety module uses sensors to warn the rider of sudden obstacles by vibrating the hand grips. Their prototype went through several iterations before achieving an 80% success rate. In the future, Ansh plans to add a processor and an AI-powered camera for even safer riding.

Other Interests: Ansh enjoys the piano and the robotics club, but he loves swimming because the training teaches him to try to be a better version of himself. He hopes to study electrical engineering because it would enable him to invent things that help society and have fun while doing it.

PRANEEL ANIL SHAH

Cupertino, California | Age: 14

Utilizing a Bioelectrochemical System with Phototrophic Bacteria to Generate Clean Water and Electricity

Project Background: The idea for Praneel's study was sparked by an article he read about bacteria that can generate electricity and how that ability can be used in microbial fuel cells that turn waste into electricity. While microbial fuel cells have been around for a long time, they do not yet generate enough electricity to serve a practical purpose, so Praneel decided to try to improve their efficiency. This led to his design of a bioelectrochemical system that he believes could generate electricity on a useable scale while, at the same time, purifying polluted water.

Tactics and Results: Praneel identified the bacteria *Rhodopseudomonas Palustris* as a good candidate for his system. Because of its high metabolism, *R. Palustris* can efficiently digest organic compounds. It also has a gene that allows it to pull electrons from iron in soil. For the first phase of his research, Praneel mixed soil, bacteria and water in a container, attached a cathode and an anode to create a battery, and connected them to a multimeter to measure electrical output. His system generated 1.2 watts per square meter. His system also generated hydrogen, which Praneel captured and used in a fuel cell. For phase two, his water purification research, Praneel combined *R. Palustris* with activated carbon and mixed it with water containing 920 parts per million (ppm) of dissolved solids. Over nine hours, dissolved solids dropped to a safer level, 240 ppm. Praneel believes his system could allow underserved communities to produce electricity and improve water quality.

Other Interests: Praneel is captain of the volleyball team, which he credits with helping him develop leadership and teamwork skills. His experience with a NASA space settlement contest ignited his interest in rocket engineering, space travel and extraterrestrial life, and has inspired him to become an aeronautical engineer.

CAMELLIA SHARMA

Henrico, Virginia | Age: 14

FishPopAI: Counting Fish Population Using Artificial Intelligence

Project Background: Fish are vital to the aquatic ecosystem, but their populations are dwindling for numerous reasons, including climate change and overfishing. Camellia's grandfather told her about how marine life is declining and how it is difficult to study habitats, especially in remote estuaries. For researchers, knowing fish populations in a body of water is essential to estimating the extent of damage and the benefits of remedial actions. Because it is not possible to physically count and categorize fish in large bodies of water, Camellia decided to develop a computerized solution.

Tactics and Results: Camellia invented a fish-counting system that uses her special 3D-printed AquaDrone, which is both an aerial drone and boat, combined with her own artificial intelligence software called FishPopAI, a hybrid of computer vision and machine learning. The computer vision component used underwater images taken by the drone to count the number of fish. Camellia tested various machine learning options using public domain photos of fish and 3D-printed models of five fish types that she created. She then randomly arranged the fish models on the floor of her backyard pool to mimic tropical schools of fish and recorded photos and videos from the moving AquaDrone, which simulated a research vessel in the field. Her FishPopAI was 94% accurate in counting and categorizing the fish. Camellia believes that AquaDrone and FishPopAI could enhance data collection and analysis for scientists trying to assess fish populations living in isolated bodies of water.

Other Interests: Camellia loves knitting, sewing, cooking and traveling the world with her family. After becoming a mechanical engineer, Camellia hopes to work in shipbuilding or the automobile industry.

PRISHA SHROFF

Chandler, Arizona | Age: 14

AI-based Wildfire Prevention System

Project Background: The length of the annual global wildfire season has increased by 19%, and fires have become increasingly severe. In addition to the health and economic effects, when forests burn, vast amounts of carbon dioxide are released into the atmosphere, contributing to climate change. The current approach to fighting wildfires is focused on detection and suppression, but after witnessing a devastating forest fire firsthand, Prisha decided to develop an intelligent system to prevent them. The key, she theorized, is early identification of places that have the appropriate weather, fuel and heat sources for wildfires to form and spread.

Tactics and Results: Prisha's AI-based Wildfire Prevention System is a fully automated, inexpensive system that uses artificial intelligence (AI) to identify fire-vulnerable areas and can then deploy drones to fly to those spots. Her system begins by loading real time NASA satellite data and NOAA meteorological data for the area being evaluated and then uses an AI random forest classifier to examine that data and identify potential fire locations. In tests, her system identified potential fire locations with an accuracy of 98%. The system then directs a drone to fly to those spots. Ideally, in the future, the automated drone will be able to apply a fire retardant there, avoiding areas where fire retardant applications are prohibited. Her system is portable and could someday be used in many locations around the world to help prevent wildfires.

Other Interests: Prisha also designed a self-cleaning solar panel to work on both Earth and Mars. She began that award-winning project after learning that the NASA Mars rover stopped working because of space dust on the solar panel. She hopes to continue to find engineering solutions to real-world problems.

JOSEPH SIMAK

Takoma Park, Maryland | Age: 15

Evaluation of Acute Toxicity of Common Motor Vehicle Water Pollutants in Artemia salina *Nauplii Model*

Project Background: Joseph was inspired to research this topic when he was visiting his beloved Chesapeake Bay and saw someone working on the engine of his motorhome camper just a few yards from the water. A stream of gas and oil was flowing right into the Bay. When he and his family returned from a fishing trip three hours later, the person had finished fixing his engine and was cleaning the camper, and the water flowing into the Bay was full of bubbles and dirt. After this experience, Joseph decided to find out how dangerous the products for car maintenance and cleaning are to marine ecosystems.

Tactics and Results: To investigate the effect of motor vehicle-related pollutants that run into marine ecosystems, Joseph studied their effect on brine shrimp, which are similar to the grass shrimp that live in the Chesapeake Bay. He tested six different pollutants at seven concentrations and counted the living and dead shrimp after 24 hours of treatment. His results showed that of the six pollutants tested, the car wash detergent and car cleaner were the most toxic and windshield fluid was the least. The toxicity of the car wash detergent and car cleaner were particularly alarming, since both are advertised as being environmentally safe, are commonly used, and enter waterways via storm drains. Joseph hopes that his study will encourage the development of less toxic alternatives to these cleaning products and raise public awareness about their effect on marine environments.

Other Interests: Joseph spends every spring break photographing reptiles in the Everglades. He would like to study venoms, especially from snakes, and develop anti-venoms for the treatment of bites from different poisonous snake species.

RAUNAK SINGH

Fair Lawn, New Jersey | Age: 12

Apollo: A Beacon of Light

Project Background: Ultraviolet-C (UV-C) light can be used to disinfect surfaces of viruses such as COVID-19 and other dangerous microorganisms. However, this kind of UV light cannot be used in the presence of people and pets because of the light's harmful effects, which can include skin burns and eye damage. Raunak decided that a sensor-equipped robot combined with a smart computer system could act by itself to disinfect a room's exposed surfaces of harmful pathogens, including COVID-19, while keeping safe any living organisms that are in, or might wander into, the area being disinfected.

Tactics and Results: Raunak designed a prototype robot, which he named Apollo, that is designed to use machine learning and motion sensors to disinfect uninhabited spaces by bathing the exposed surfaces in potentially harmful UV-C light. He tested his concept using a prototype that he built at home from available supplies and using blue LEDs to safely represent the UV-C light source. The robot has two sensors on the sides of its chassis to detect any motion, so the robot can detect if a person or pet is moving in the room. As a further safeguard, Raunak equipped Apollo with a camera that takes photos as the robot moves through an area. The photos are analyzed by the robot's computerized machine learning software to evaluate whether Apollo can safely disinfect that space. Whenever movement is detected, the UV-C light is stopped until the prototype robot determines that the coast is clear.

Other Interests: Raunak wants to pursue a career in electrical engineering and computer science, both of which require skills he needed for this project. He enjoys basketball, swimming, skiing and karate and is looking forward to rejoining the violin section of his youth orchestra.

MAYA TANG

Shaker Heights, Ohio | Age: 14

How Do Mask Types and Instrument Covers Affect Aerosol Spread and Sound Level During Music Performance?

Project Background: Music performance is an important part of Maya's life. At the beginning of the pandemic, her music school closed for several months, and when it reopened, all of her classes were virtual. In her middle school, music classes were moved outdoors, even when the weather in Northeast Ohio grew cold. Maya decided to study if singing and playing wind instruments could be done safely indoors using face coverings and instrument covers and whether the coverings would muffle the sound of either.

Tactics and Results: For the singing portion of her research, Maya selected gaiter, cotton, surgical and N95 masks as well as a plastic face shield. For the woodwind portion, she used a recorder with and without a fabric cover. As a surrogate for the coronavirus, she chose a powder that can be viewed under ultraviolet light and is the same size (5 microns) as the virus. A person then sang Happy Birthday five times, once while wearing each mask type and then once without a mask as a control. Each time, Maya measured how far the powder spread. Without a mask, it spread 41.2 cm, with a gaiter mask it spread 14.2 cm and with all other masks there was no spread. Using a sound meter, she found that the cotton and surgical masks did not affect sound of the voice. She had similar results with the recorder. If further testing confirms her findings, Maya believes, masks and covers could allow singing and the playing of wind instruments to be done safely in schools.

Other Interests: Maya enjoys playing the piano and singing classical and popular songs. She is also a competitive figure skater who started training at age four but has not been on the ice since the pandemic began. Maya, who comes from a family of medical practitioners, hopes to become a physician so that she can help others, too.

LUCY ANGEL TENG

Louisville, Kentucky | Age: 14

The Effects of SARS-CoV2 Non-structural Proteins on Cytokine Induction

Project Background: One day while riding in a car, Lucy was half listening to a radio report about COVID-19 vaccines. She did not remember much about the report except for the repeated reference to the spikes on proteins, so she decided to learn more about them. Lucy discovered that it is the structural protein (the spike) on the outside of the COVID-causing virus that's often shown in illustrations. She also found that while the virus also has 16 non-structural proteins (NSPS), most vaccine research was focused on structural proteins. She committed herself to researching the effects of non-structural virus proteins on the immune response.

Tactics and Results: Lucy discovered that researchers focus largely on structural proteins, like the spike protein, because they believe they contribute to an immune response called a cytokine storm. Cytokines are a variety of tiny molecules that act as messengers to tell your immune system to do its job. In a storm, too many cytokines are produced, and this can damage organs like the lungs. Lucy conducted her research in a laboratory where she cultured U937 macrophage cells (a white blood cell that kills microorganisms and releases cytokines). Then she introduced two nonstructural virus proteins, NSP12, NSP13, and the spike protein into the macrophage cultures. When she analyzed the medium in which the cells had been grown, she found that the non-structural proteins had also caused the release of cytokines, though not as much as the spike protein did. She believes that research like hers will help in the development of more effective treatments.

Other Interests: Lucy plays piano and clarinet and takes classes in three different dance styles: lyrical, jazz and tap. But she most enjoys swimming, which has helped her develop grit and led to great friendships. Still searching for her dream career, she is leaning toward psychology to learn about the human mind and help others.

HAILEY MIYA VAN

Irvine, California | Age: 14

Multi-stressor Analysis of Carbon Dioxide on Oceanic Ecosystems: Using Climate Change Modeling to Study Hypoxia and Acidification

Project Background: Hailey is interested in the marine environment, specifically aquatic chemistry and how human processes have led to unnatural, potentially deadly conditions in the ocean ecosystem. In particular, she was intrigued by hypoxia, a dangerous low oxygen condition. To try to predict future hypoxia levels, Hailey studied global climate models, which can simulate large, complex processes in the ocean, atmosphere and land. She believes that society should prepare for the eventual impacts of climate change, while also doing everything possible to reduce them.

Tactics and Results: Hailey combined computer modeling with environmental science to determine the possible effects of continued climate change on the world's oceans. Using a model from a New York university, Hailey projected sea surface temperatures, ocean acidity and the extent of ocean hypoxia with five different carbon dioxide (CO_2) scenarios. Her modeling indicated that if current upward trends of CO_2 emissions continue, ocean hypoxia will increase from the 30% recorded in the year 2000 to 53% in 2150, and lead to much worse acidity levels. In contrast, a slowed growth rate of CO_2 and high levels of oversight would lessen the environmental harm, decrease the predicted hypoxia percentage to 40% and limit ocean acidification to only an additional 2%.

Other Interests: Hailey has performed ballet for 11 years. She has also volunteered with an organization that delivers online STEM-based activities to younger students. She is interested in both climatology and food science.

ANGELA ZHAN

Logan, Utah | Age: 14

Biological Transformer: Constructing Novel Microbial Cell Factories to Convert Plastic Wastes to Environmentally Friendly Bioplastic

Project Background: Angela developed a way to convert petroleum-based plastic wastes into environmentally friendly, biologically produced plastic (bioplastic) after learning that plastic pollution has become one of the world's most pressing environmental issues. Most plastics are oil-based and highly resistant to biodegradation, and thus pose a serious, long-term threat to the environment and human health. Biologically converting oil-based plastic wastes into a more biodegradable bioplastic will reduce carbon emissions while allowing us to continue to enjoy the convenience of plastic in our daily life.

Tactics and Results: Angela suspected that some microbes in Utah's Great Salt Lake might have developed the ability to metabolize various carbon sources including plastic because of the limited amount of carbon in the highly salty water. First, she used low-density polyethylene (LDPE) as a carbon source to help find useful microbes from the Great Salt Lake. After identifying two strains of bacteria that could grow on a diet of plastic bags, she set about editing the genes of these two bacterial strains so they could produce bioplastic (PHB). The two genetically engineered strains were able to convert LDPE into PHB at rates of 51.8% and 43.1%. By producing two bacteria strains that can efficiently transform oil-based plastic wastes into environmentally friendly bioplastic, her work suggests a novel path to the problem of global plastic pollution.

Other Interests: Angela plays piano and viola, is a member of her school orchestra and regularly plays for senior citizens at a local assisted living center. She also enjoys swimming, skiing, and playing soccer and tennis. She hopes to make the world healthier and more sustainable by becoming an environmental engineer.

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Broadcom MASTERS

THE INSPIRATION

In recognition of the importance of STEM education and the importance of sparking insight and developing 21st Century skills through project-based learning, the Broadcom Foundation is proud to sponsor the Broadcom MASTERS and congratulates all finalists for their hard work and dedication to following their passions in science, technology, engineering or math.

The inspiration to sponsor the Broadcom MASTERS is found in the personal history of Broadcom's co-founder, Dr. Henry Samueli.

Just like the thousands of young people competing in science fair competitions throughout the United States and the world, Henry Samueli's storied career in electrical engineering was ignited during the formative years of middle school with a 'hands-on' electronics project in his West Hollywood 7th grade electric shop class.

Henry Samueli convinced his teacher to let him construct a vacuum-tube short-wave radio from a Heathkit catalog that he worked on every night for an entire semester. When he brought the assembled radio into school, the teacher plugged it in and it worked.

From that moment on, Henry Samueli was hooked on electrical engineering. "That became my mission in life, from 7th grade onward, to find out how radios work." He went on to earn his Bachelor's, Master's and Ph.D. degrees in electrical engineering at UCLA and his amazing career trajectory as an engineer/innovator led to the founding of Broadcom, today an international Fortune 500 company known as Broadcom Inc.

Broadcom Foundation and Society for Science & the Public thank Dr. Henry Samueli and his wife Dr. Susan Samueli for their generosity in presenting the Samueli Foundation Prize, the top award of $25,000, at the Broadcom MASTERS.

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Founded in April 2009, the Broadcom Foundation is a 501(c)(3) nonprofit with the mission of advancing science, technology, engineering and math (STEM) education by funding research, recognizing scholarship and increasing opportunity.

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