REGENERON

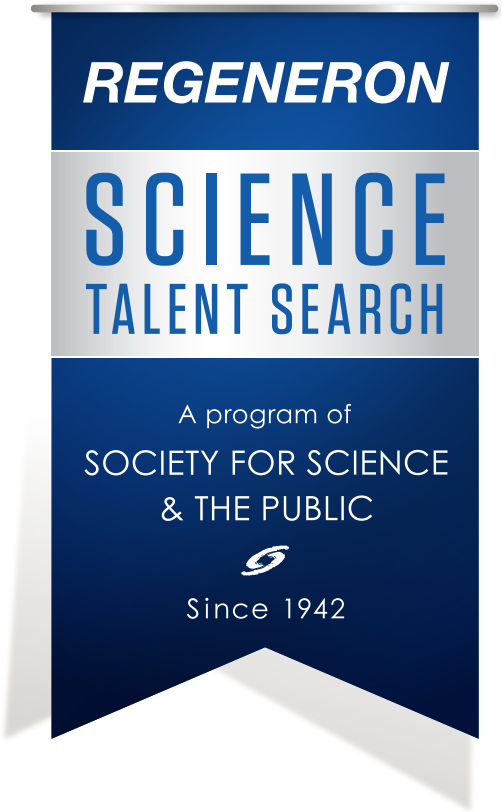
SCIENCE TALENT SEARCH

A program of
SOCIETY FOR SCIENCE & THE PUBLIC

Since 1942

REGENERON SCIENCE TALENT SEARCH

2019 FINALISTS



2019 FINALISTS

The Regeneron Science Talent Search (Regeneron STS), a program of Society for Science & the Public, is the nation's oldest and most prestigious science and math competition for high school seniors. Alumni of STS have made extraordinary contributions to science and hold more than 100 of the world's most distinguished science and math honors, including the Nobel Prize and the National Medal of Science. Each year, 300 Regeneron STS scholars and their schools are recognized. From that select pool of scholars, 40 student finalists are invited to Washington, D.C. in March to participate in final judging, display their work to the public, meet with notable scientists and compete for awards, including the top award of $250,000.

REGENERON SCIENCE TALENT SEARCH 2019

MARCH 7–13, 2019

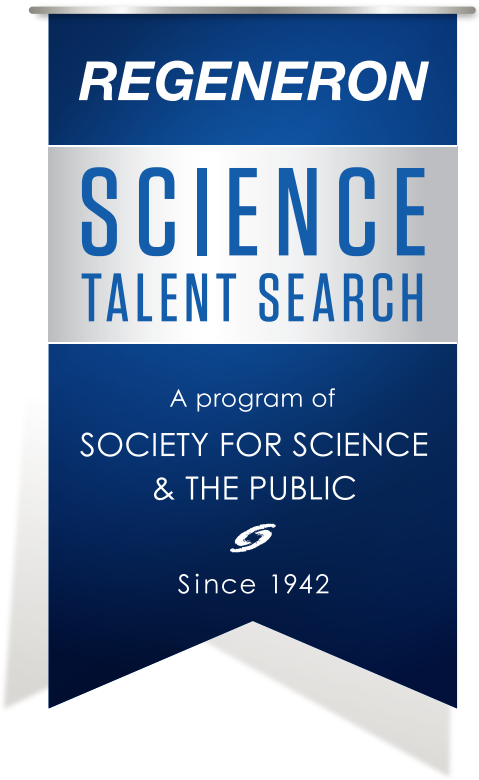
The 40 finalists of the Regeneron Science Talent Search 2019, a program of Society for Science & the Public, were selected based on the scientific rigor and world-changing potential of their research projects. These students have been awarded an all-expense paid trip to Washington, D.C., to attend the Regeneron Science Talent Institute, where they will compete for $1.8 million in awards.

The 40 finalists come from 34 schools in 17 states. Finalists were selected from almost 2,000 entrants, representing more than 600 high schools in 48 states, the District of Columbia, Puerto Rico and ten countries.

Unique among high school competitions in the U.S. and globally, the Regeneron Science Talent Search focuses on identifying the next generation of scientists and engineers who will provide critical leadership in solving some of the world's most pressing challenges while shaping the future of research and development for our nation and the world.

Many projects are the product of a research environment in which scientist mentors and teachers dedicate themselves to the intellectual development and technical training of students who participate in the Regeneron STS. The Regeneron STS 2019 finalists, Regeneron and Society for Science & the Public acknowledge with gratitude the guidance, expertise and patience of the experienced researchers who made many of these projects possible.

Table of Contents



History

The Science Talent Search (STS), a program of Society for Science & the Public since its launch in 1942, is the nation's oldest and most highly regarded science competition for high school seniors. The Regeneron STS provides an incentive and a forum for U.S. high school seniors to complete an original research project and to be recognized by a national jury of accomplished professional scientists, mathematicians and engineers.

Regeneron became only the third sponsor of the Science Talent Search, following previous sponsors Westinghouse and Intel. As part of its ten-year, $100 million commitment, Regeneron significantly increased awards to better reward the nation's brightest young scientists and encourage their continued pursuit of scientific innovation. In total, this year's finalists will receive over $1.8 million in awards provided by Regeneron, and overall, Regeneron will distribute $3.1 million in awards to the Regeneron Science Talent Search 2019 finalists, scholars and their schools.

The projects are a result of inquiry-based learning methods designed to nurture critical reasoning skills, experience research through the use of the scientific method and demonstrate how math and science skills are crucial to making sense of today's technological world. Historically, the top 300 applications are identified from a pool of entrants from which 40 finalists are then selected from this prestigious group.

Since 1942, the STS has recognized 23,571 finalists and scholars who have received $24.4 million in awards as they launch their college careers. Many STS participants have gone on to distinguished careers; alumni of the STS include more than 100 recipients of the world's most distinguished science and math honors, including the Nobel Prize, National Medal of Science, Fields Medal, MacArthur Foundation Fellowship and Breakthrough Prize.

The Process

Students submit an extensive written report of their scientific research to demonstrate creativity and interest in science, as well as supporting documents from schools, advisors and mentors.

While in Washington, D.C., finalists meet leading scientists, visit places of historic and political importance and meet with distinguished national leaders. Finalists will display their research at The National Geographic Society, where they describe their work to visitors. Many of those studying the exhibits are highly motivated younger students who aspire to enter the Regeneron Science Talent Search in their senior year of high school.

Awards

Finalists will compete for more than $1.8 million in top awards – more than half of the Regeneron STS total annual award distribution of $3.1 million. The top ten awards range from $40,000 to $250,000 for the first place winner. Winners are selected by the judging committee and announced at a formal awards gala at the National Building Museum on March 12.

Each of the 300 students named a scholar in the Regeneron STS 2019 receives a $2,000 award for their outstanding science research, in addition to any amount that students may win as finalists. Each of their schools receives an award of $2,000 for each scholar named in the Regeneron STS 2019. The award is used to advance excellence in science, math and/or engineering education at the recipient school.

2019 FINALISTS

Ayush Alag

The Harker School
California

Ayush Alag, 17, of **Santa Clara**, used machine learning to identify a gene-based diagnostic signature for food allergy for his Regeneron Science Talent Search **computational biology and bioinformatics** project. His interest in creating a safe diagnostic tool stems from childhood when he risked life-threatening anaphylaxis to have his own allergic status confirmed through a test known as the oral food challenge (OFC). Ayush designed a feature-selection algorithm to analyze patients' blood profiles and mapped his findings to a 13-gene signature. His algorithm required substantially less biological information to select features and used significantly fewer sites on the genome than a previous study that attained similar accuracy. His methodology also is easily replicable and entails none of the health risks of OFC. His work may improve screening for allergies and could lead to potential drug targets for autoimmune disease. Ayush attends **The Harker School** in San Jose where he plays violin in the orchestra and performs with Kinetic Krew, a competitive dance troupe. The son of Alpana Verma-Alag and Satnam Alag, Ayush has formed a private company, Allergezy Inc., to continue his research.

Adam Ardeishar

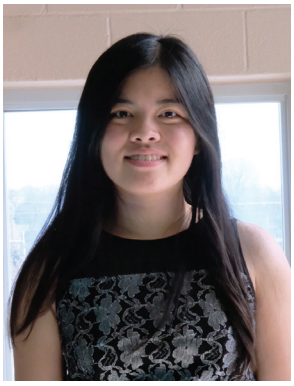
Thomas Jefferson High School for Science and Technology
Virgina

Adam Ardeishar, 17, of **McLean**, found a connection between Markov chains and extreme value theory for his Regeneron Science Talent Search **mathematics** project. Markov chains are used by companies such as Google to rank webpages and by hedge fund managers to track the stock market. A mathematical application of Markov chains is called the "coupon collector problem," an example of which is estimating how many kid's meals you must buy before you get at least one of every toy being offered. Extreme value theory is used to determine the likelihood of a maximal event. For example, structural engineers use it to calculate how likely a bridge is to collapse; meteorologists use it to assess the chance of a 1,000-year flood. Adam related the maximum of various data sets to a generalized coupon collector problem and then developed an algorithm to calculate the real-world values of such data. Adam attends the **Thomas Jefferson High School for Science and Technology** in Alexandria. The son of Raghu and Samim Ardeishar, Adam is most proud of being one of six students chosen to participate in the 2018 International Math Olympiad, where he earned a silver medal and helped the U.S. team win the event.

Carolyn Beaumont

The Potomac School
Virgina

Carolyn Beaumont, 17, of **Arlington**, investigated how the quantity of added water affects the viscosity of magma, a key factor in the violence of volcanic eruptions, for her Regeneron Science Talent Search **earth and planetary sciences** project. Current infrared spectroscopy models suggest that the amount of water reacting with magma to make it runny ultimately levels off, leaving the magma's polymer bonds stretched but intact. Using nuclear magnetic resonance spectroscopy, Carolyn showed that the degree to which water breaks apart magma polymers actually rises in proportion to the total amount of water present. These findings may inform models of magmatic properties and movement, allowing greater insight into volcanic eruptions and the geological carbon cycle, both of which are critical to climate change calculations. Carolyn captains the math and varsity tennis teams at **The Potomac School** in McLean where she also plays viola in the string orchestra and is co-founder and leader of the Math and Science Collaboration Center for peer tutoring. Her community volunteer activities include co-leadership of the YouToo Tennis program for children with autism. Carolyn is the daughter of Amy and Craig Beaumont.



Grace Cai

Montgomery Blair High School
Maryland

Grace Cai, 17, of **Potomac**, completed a **computer science** project for the Regeneron Science Talent Search studying swarming robots, which must perform individually, and yet together, in ways similar to the flocking behavior and formations of birds in flight. Unlike a classical algorithm that guides a single device, a swarm algorithm runs on hundreds of different devices at the same time, guiding their actions as a collective. A time/accuracy trade-off is necessary to efficiently produce this behavior in a group of devices, such as robots or drones: Which is more important, an accurate decision or a fast one? In simulations, Grace's algorithm achieved over 97 percent target accuracy in low urgency situations. In high urgency cases where speed is primary, all devices arrived safely in just four minutes. Everyday applications may include devices used for military operations and search and rescue missions. At **Montgomery Blair High School** in Silver Spring, Grace is captain and presenter for two different clubs, the Computer Team and Code Girls. The daughter of Qi Zhao and Duo Cai, Grace also is drawn to visual arts as it requires a combination of physical, mental and emotional focus to effectively convey the artist's meaning.

2019 FINALISTS

Anjali Chadha

duPont Manual High School
Kentucky

Anjali Chadha, 16, of **Louisville**, developed a portable, affordable and easy-to-use arsenic sensor for her Regeneron Science Talent Search **environmental science** project. Anjali was inspired to develop the sensor when she learned that water resources within 90 miles of her home were contaminated with arsenic, a known carcinogen, and that individuals who depend on well water would never know that they were drinking contaminated water. In 2016, she began designing and building a prototype that was semiautomatic and not very user-friendly. She has since fully automated the concept, incorporating, among other things, 3D-printed electronic components and a novel approach to sequentially add the required chemicals to the water sample. Her new device consistently achieves an error rate of 5 percent or less. Anjali is founder and CEO of Empowered, Inc., a non-profit organization that teaches and mentors girls in web design and other STEM technologies. A student at **duPont Manual High School**, and the daughter of Vidya Ravichandran and Vik Chadha, Anjali has performed Indian classical dance internationally and was one of nine students featured in the award-winning National Geographic documentary film, "Science Fair."

Lyron Co Ting Keh

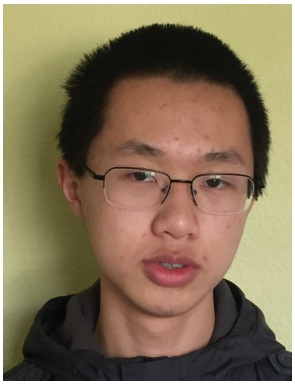
Crescenta Valley High School
California

Lyron Co Ting Keh, 17, of **La Crescenta**, submitted a Regeneron Science Talent Search **computational biology and bioinformatics** project studying metastatic cancers of unknown primary (CUP), the fourth leading cause of cancer-related deaths worldwide. For patients with CUP, the site of the original tumor cannot be determined without using risky and costly tumor-based diagnostic tests. Hoping to build a cost-effective model that predicts tissue of origin using only a blood sample, Lyron devised a way to work with a "liquid biopsy" to detect circulating tumor DNA. In tests, his diverse set of machine learning algorithms achieved an accuracy rate of 93.5 percent on 522 actual patient samples, an 18 percent improvement over current non-invasive methods. At **Crescenta Valley High School**, Lyron's activities include football, volleyball, robotics, science bowl and the algorithmic coding team. He is founder and CEO of CV Enterprises, which trains and tasks teams of programmers from multiple high schools to design, program and deliver web and app development projects to clients. His parents are Rowena and Edmondo Co Ting Keh.

Samuel Ferguson

West Windsor-Plainsboro High School
New Jersey

Samuel Mark Ferguson, 18, of **West Windsor**, used computer modeling to design a blended wing body (BWB) aircraft capable of replacing a typical airliner for his Regeneron Science Talent Search **engineering** project. Traditional tube and wing (TAW) aircraft, while simple, are not aerodynamically efficient because the tube-shaped cargo/passenger area provides little or no lift. BWB aircraft, like flying wings, use the entire wing-and-body surface to provide lift, reducing weight and fuel consumption. Sam began his research with three families of aircraft and used a Darwinian style genetic algorithm to select for the best features of each. His final design resembles a TAW aircraft more than a flying wing and would carry 200 passengers. He estimates that his design would use 40 percent less fuel than a similar capacity traditional aircraft, generate less greenhouse gas and require less material to build. Sam is a CAD director for the robotics team at **West Windsor-Plainsboro High School** in West Windsor. An Eagle Scout with four palms, he earned his rank by creating an osprey nesting site at a local preserve. The son of Mark and Melody Ferguson, he hopes to study aerospace engineering and work in research at NASA.



Vincent Huang

Plano West Senior High School
Texas

Vincent Huang, 18, of **Plano**, developed a computer model that predicts refugee migrations on a localized regional scale for his **behavioral and social sciences** Regeneron Science Talent Search project. Vincent's two-part model combined a weighted graph representing real-world geography and matrices to show the movements of people within it. He then tested the model using data from the 2015–2016 refugee crisis that resulted from the civil war in Burundi, Africa. Vincent observed that refugees behave differently when traveling short, medium and long distances, especially regarding their choices to use shortcuts or main roads. He believes his algorithm is more accurate and less complex than previous models. Vincent's research may help nonprofits and government entities more efficiently allocate resources by better anticipating the movement of vulnerable refugee groups. In his leisure time, Vincent enjoys running, even completing a half-marathon. The son of Cathy Li and Lixian Huang, Vincent passionately promotes learning as a math tournament director and founder of Magic Math for middle schoolers. He attends **Plano West Senior High School**, where he plays cello in the orchestra that was recognized in 2017 and 2018 as the best in Texas.

2019 FINALISTS

Ana Humphrey

T.C. Williams High School
Virgina

Ana Humphrey, 18, of **Alexandria**, applied her Regeneron Science Talent Search **space science** project to find the existence and probable locations of exoplanets missed by the Kepler Space Telescope. These planets that orbit stars beyond our solar system are revealed using the transit method, which measures a star's decrease in brightness when a passing body blocks its light; however, those outside our "plane of view" or too small to dim much light may go undetected. Based on an accepted hypothesis that planetary formation creates dynamically packed systems, Ana used mathematical modeling to seek "unpacked" spaces and determine whether a new planet could fit between those known to be nearby without disrupting their orbits. Her research, which further informs the structure of Kepler multiplanet systems, found as many as 560 missing planets and identified 96 as prime search targets based on locations of other planets in their systems. At **T.C. Williams High School** she founded Watershed Warriors, a program promoting environmental awareness among fifth-graders. She also volunteered with Inspire Virginia to turn out the youth vote statewide and in the D.C. metro area. Her parents are John Humphrey and Luisa Tio.

Navami Jain

North Carolina School of Science and Mathematics
North Carolina

Navami Jain, 18, of **Charlotte**, submitted a Regeneron Science Talent Search **biochemistry** project studying the production of bioethanol from wheat straw, an agricultural byproduct that typically goes to waste. Bioethanol is produced by converting plant residues into simple sugars for fermentation. Current bioconversion processes require the composite plant materials to be preprocessed via hydrolysis, a time-consuming process, into separate fermentable sugars. Navami's research explored a one-step hydrolysis alternative using ionic liquids (ILs) to expedite the transformation of wheat straw into simple sugars. Her results suggest that a 40 percent concentration of ILs in a one-pot conversion system may increase efficiency and lower costs of bioethanol production, leading to more sustainable and affordable methods. Navami attends the **North Carolina School of Science and Mathematics** in Durham. The daughter of Chaula and Jitendra Jain, she co-founded an e-commerce site to distribute food byproducts from suppliers to local farmers for livestock feed. She also is an accomplished dancer who has studied multiple styles for over 13 years and hopes to pursue parallel careers in both science and dance.

Aayush Karan

University School of Milwaukee
Wisconsin

Aayush Karan, 17, of **Muskego**, untangled a mystery in knot theory for his Regeneron Science Talent Search **mathematics** project. If I give you two strings that each have been knotted and then had their respective ends tied together, how can you determine if they were knotted in the same way? This problem has been perplexing mathematicians for hundreds of years. A key tool that mathematicians use to solve this problem is called an invariant, a quantity that does not change when a knot is jumbled. Mathematicians have discovered useful invariants to solve this problem, but computing them for a collection of intertwined knots (or links) can be very difficult. Aayush applied tools from algebra, topology and combinatorics to show that all links with a nonzero determinant can be generated by, at most, two links, which can then be used to simplify the calculation of invariants. Because DNA can only knot in certain ways, an advancement in knot theory could improve our understanding of DNA. Aayush, the son of Dev Karan and Seema Dubey, attends the **University School of Milwaukee** where he runs cross country. Aayush enjoys playing the piano, which allows him to "experience passions and moments across time and space."

Ananya Karthik

Saint Francis High School
California

Ananya Karthik, 17, of **Sunnyvale**, crafted an ultrasound-activated drug delivery system for her Regeneron Science Talent Search **materials science** project. Ananya's desire to improve methods of drug delivery to the brain was motivated by her grandmother's struggles with dementia. Delivering medications to brain tissues is complicated by the highly selective blood-brain barrier (BBB). Ananya characterized biodegradable nanoparticles with the ability to encapsulate sedative medications and release them to passively cross the BBB when exposed to a focused ultrasound beam which is harmless to the patient. Ananya foresees broad applications for targeted nanoparticle-based drug delivery. Cancer treatment, sedative delivery and the targeted treatment of psychiatric disorders are a few of the uses she proposes. The daughter of Sukhmeen Kaur and Karthik Srinivasan, Ananya attends **Saint Francis High School** in Mountain View where she is the editor-in-chief of the newspaper, co-president and CTO of the environmental club and co-captain of her science bowl team. She also leads an outreach initiative to encourage young women to pursue STEM careers.

2019 FINALISTS

Preeti Sai Krishnamani

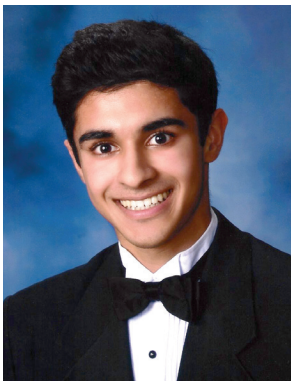
Charter School of Wilmington
Delaware

Preeti Sai Krishnamani, 17, of **Hockessin,** investigated whether adding plant-based silicon materials to rice paddies could reduce arsenic contamination in rice for her Regeneron Science Talent Search **plant sciences** project. Silicon had previously been shown to decrease uptake of toxic arsenic in rice plants, but few studies have examined the effect of silicon soil amendments on soil chemistry, specifically iron oxide minerals that adsorb arsenic. Preeti examined three types of silicon-rich materials – silica, fresh rice husks and rice husk ash – to determine their effect on soil chemistry and arsenic uptake in flooded rice paddies. Her results indicate that rice husk ash, a biodegradable and cost-effective material, was most effective for increasing concentrations of beneficial iron oxides in the paddies. She also demonstrated that iron oxide concentrations could be greatly increased by not flooding the rice paddies, further limiting arsenic contamination. A student at the **Charter School of Wilmington** Preeti leads mentors in the Refugee Acculturation Program, an organization she founded in 2015 to empower refugees in her community through English and STEM education. Her parents are Parimala Krishnamani and Krishnamani Ramasubramaniam.

Chirag Kumar

Horace Greeley High School
New York

Chirag Kumar, 17, of **Chappaqua**, used machine learning to more accurately measure sea surface temperatures (SST), the single most important indicator of climate change, for his Regeneron Science Talent Search **earth and planetary sciences** project. Ocean buoys provide accurate SST measurements, but don't have the coverage needed for global climate change models. Sensors on NASA's Aqua satellite can provide the global SST measurements necessary for modeling, but clouds and other variables introduce errors. Chirag tackled this problem by first identifying seven variables with the greatest influence on SST error. He then applied a machine learning algorithm (the Cubist decision tree), which he adapted for this research, and was able to clearly identify conditions that yielded SST errors lower than 0.40 degrees Celsius – the ultimate goal in the field of climate research. Chirag captains the varsity swim team at **Horace Greeley High School**. Using knowledge gained from building a computer for his project, he formed a group that refurbishes computers for a vocational school. An accomplished cellist and amateur composer, he is producing a CD of his own fusion music. Chirag is the son of Poonam Arora and Arvind Kumar.



Varun Kumar

Bergen County Academies
New Jersey

Varun Kumar, 17, of **Woodcliff Lake**, submitted a Regeneron Science Talent Search **medicine and health** project in which he developed a combinatorial therapy that may reverse resistance to temozolomide (TMZ), a drug commonly used to treat glioblastoma, the most aggressive type of adult brain tumor. In three separate trials, Varun treated brain cancer cells in culture with TMZ; with the newer drug dihydrotanshinone (DHT), a form of which is currently in clinical trials; and with a combination of both drugs at the same time. The combination treatment not only showed that cells regained sensitivity to TMZ and divided significantly less rapidly, but also demonstrated synergy, producing a greater anti-cancer effect than either drug alone. Further, Varun found that DHT does not substantially affect normal cells and he used a self-built model of the blood-brain barrier to validate that DHT molecules could reach the brain. His work may help to amplify the effects of common chemotherapies. Varun attends **Bergen County Academies** in Hackensack where he plays tennis and co-captains the Oncology Olympiad team. The son of Priyanka and Yashdeep Kumar, Varun is first author of publications in two journals, *Anticancer Research* and *Biomedicine & Pharmacotherapy*.

Thomas Lam

Syosset High School
New York

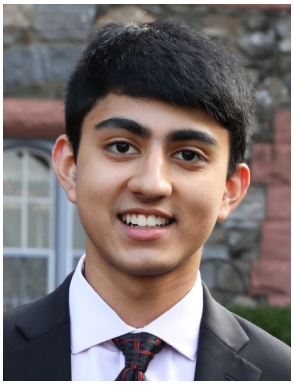
Thomas Lam, 17, of **Jericho**, identified which number rotation puzzles are solvable and developed algorithms to solve them using tools from abstract algebra for his Regeneron Science Talent Search **mathematics** project. In the classical version of the number rotation puzzle, one tries to unscramble a square three-by-three grid of numbers by rotating two-by-two blocks of numbers clockwise. Although solving these puzzles can be fun, they are also the subject of serious mathematical study. Previous work on these puzzles discovered which square puzzles larger than three-by-three could be solved using rotations one block smaller than the size of the puzzle. Thomas extended this concept by considering rotations of any size, and even rectangular boards that are not square. In addition, he developed an algorithm that gives the moves needed to solve every puzzle that can be solved. Thomas is president of the Mathletes team and the chess club at **Syosset High School**, and leads the Theta Math Club, an organization that teaches problem-solving mathematics to elementary and middle school students. The son of Kit and Wayne Lam, Thomas is also a violinist in the New York All-State Symphony Orchestra.

2019 FINALISTS

Gabrielle Kaili-May Liu

Ravenwood High School
Tennessee

Gabrielle (Kaili) Liu, 17, of **Nashville**, studied the problem of catastrophic forgetting by neural networks for her Regeneron Science Talent Search **computer science** project. Kaili likens this computer issue to a human forgetting how to brush teeth after more recently learning how to floss. Her baseline model which learned to recognize handwritten numbers with 98 percent accuracy and later to categorize pictures of assorted objects, dropped to only 33 percent accuracy when re-evaluated on the first task. To reduce this "forgetting," she borrowed principles from physics and neurology, creating and incorporating a concept called weight friction into her learning model and significantly improving the accuracy of the re-evaluated task with only a slight decrease in overall model performance. Kaili believes her findings will help computer networks learn continuously over time in a more human-like way and aid artificial intelligence applications. A student at **Ravenwood High School** in Brentwood, Kaili also developed an algorithm for home assistant devices (such as Alexa) to recognize emotional patterns as a way to address domestic violence issues, a contribution that earned a 2018 Society for Science & the Public Community Innovation Award. Kaili is the daughter of John Liu and Catherine Lu.



Eish Maheshwari

Herricks High School
New York

Eish Maheshwari, 16, of **New Hyde Park**, explored the viability of binding drug-loaded nanoparticles (NP) to red blood cells (RBCs) to more effectively deliver drugs for his Regeneron Science Talent Search **medicine and health** project. RBCs possess many features of ideal drug carriers: they are long lived, and drug-loaded nanoparticles bound to them are not rapidly metabolized in the liver. Eish chose to work with curcumin as a model drug because of enticing preliminary data supporting its medicinal use; however, it is not readily absorbed and is quickly metabolized. His three-step process consisted of bonding phosphatidylcholine (PC) to curcumin, loading the curcumin-PC complex into silica nanoparticles for optimizing drug release and finally, attaching the nanoparticles to RBCs via electrostatic interactions of the PC and the cell. Eish believes that his RBC-nanoparticle system is viable and has widespread medical potential. At **Herricks High School**, Eish is a Mathlete, co-founder of the Quiz Bowl club, competes in the Science Olympiads and is captain of the robotics team. The son of Nilima and Aditya Maheshwari, Eish loves to perform sleight-of-hand card magic and was a Taekwondo instructor with a 2nd Dan black belt.

Sai Preethi Mamidala

Garnet Valley High School
Pennsylvania

Sai Preethi Mamidala, 17, of **Garnet Valley**, submitted a Regeneron Science Talent Search **chemistry** project that investigated a novel catalyst for use in formate-based reversible fuel cells. The benefits of formate as an electrochemical fuel and energy storage method are directly dependent on the catalyst used to trigger the oxidation reaction. Sai found that her palladium-nickel alloy exhibited high current density, longer operational longevity and more reversible behavior than two other commonly used alloys. She was inspired to begin her research while visiting her native India where she witnessed the effects of fossil fuel pollution first-hand. In addition to serving with several STEM organizations at **Garnet Valley High School** in Glen Mills, Sai founded and continues to head the school's chapter of the Society of Women Engineers. She also plays violin and is an active member in the school's orchestra. A prolific baker, her love of experimentation extends to the kitchen where she enjoys creating "dessert imposters" – sweet treats masquerading as savory items. The daughter of Gyaneswar and Pavana Mamidala, Sai plans to continue her research as she pursues a career developing renewable energy technology.

Natasha M. Maniar

The Harker School
California

Natasha M. Maniar, 17, of **Sunnyvale**, developed a computational approach to identify sources of atrial fibrillation (AF) for her Regeneron Science Talent Search **computational biology and bioinformatics** project. Despite affecting more than 33 million people worldwide, diagnostic imaging of electrical conduction through the heart remains relatively subjective and continues to rely heavily on visual interpretation by experts. Natasha addressed this as a two-fold problem. She first developed an algorithm to analyze the heart's chaotic electrical signals and then interpreted those results using her computational tool. Her code identified the AF sources inside the heart with greater accuracy than trained experts. The daughter of Mita and Mihir Maniar, she was motivated to study AF after both of her grandfathers were diagnosed with the disorder. Natasha is a student at **The Harker School** in San Jose where she serves as co-president of the artificial intelligence club she founded. She also volunteers as a writing mentor to middle school students. In her leisure time Natasha enjoys teaching and performing competitive dance, a talent that has earned her numerous accolades over 14 years of study.

2019 FINALISTS

Braden Nicholas Milford

Cascia Hall Preparatory School
Oklahoma

Braden Nicholas Milford, 17, of **Tulsa**, developed a biological method to remove metals from contaminated water for his Regeneron Science Talent Search **environmental science** project. Braden collected water samples from and near abandoned mining areas that have been designated Superfund sites and isolated bacteria that could tolerate high metal concentrations. He then determined which of these bacteria could form sticky "biofilms" that facilitate metal removal, identified and sorted them by their DNA, and combined concentrated mixtures of these bacteria with green algae, which he encapsulated in permeable sodium alginate beads. The algae provides the bacteria with food and oxygen, while the bacteria and the biofilm protects the algae by removing at least 80 percent of most of the metals. Braden heads the science research team at the **Cascia Hall Preparatory School**, where he used to run on the varsity cross-country team. The son of Cindie and Aaron Milford, Braden is an Eagle Scout and president of an organization that was formed in 2016 to raise awareness and private donations when the science fair program was cut from the state budget. These efforts led to restored funding in the 2019 budget.

Emma Joy Montgomery

Ossining High School
New York

Emma Joy Montgomery, 18, of **Ossining**, conducted research on genetic editing for her Regeneron Science Talent Search **bioengineering** project. CRISPR base editing (BE) is a genetic editing tool that can repair or model DNA mutations using an enzyme to replace one of the four DNA bases with a different one. BE has enormous potential, but its application is restricted by its limited editing range, low rate of editing and the process of selecting a guide RNA to target the proper base. To improve editing efficiency, Emma reengineered the original BE enzyme and developed two new, more efficient versions. She also developed a method for determining the efficiency of a guide RNA, independent of the target site. Emma is co-author of an article that includes her research in *Nature Biotechnology*. The daughter of Susan and Bryan Montgomery, Emma attends **Ossining High School** where she is the viola section leader in the string ensemble and active in social justice causes. Outside of school, Emma divides her time between her two passions, scientific research and dance. She is a senior company member and soloist in the Westchester Ballet Company and a teaching assistant for Logrea Dance Academy

Ahmad Amin Perez

Brentwood High School
New York

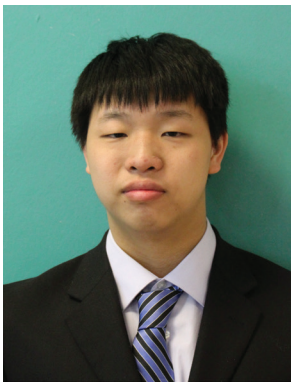
Ahmad Amin Perez, 17, of **Brentwood**, investigated strategies for salt marsh restoration for his Regeneron Science Talent Search **environmental science** project. Salt marsh loss is occurring globally at an alarming rate due to increased erosion, rising sea levels and fertilizer-contaminated runoff. Ahmad used satellite images of two tidal marshes and analyzed how the width of marsh ditches, which had been created to control mosquito populations, had expanded over 13 years due to erosion. He then collected sediment samples at regular intervals from both marshes and measured nitrate concentrations at each location. Ahmad found that ditches with greater nitrate levels and less tidal nutrient flushing had experienced a significantly greater rate of degradation, indicating that erosion may be exacerbated by elevated nitrate levels. He then demonstrated how adding biopolymers to the sediment can improve plant growth and water retention, thereby increasing resistance to simulated tidal stress. The son of Denis and Aicha Perez, Ahmad attends **Brentwood High School**, where he serves as Deputy Group Commander of the Air Force Junior ROTC program, for which he received the Tuskegee Airman Inc. Award and Top Performer Recognition.

Brent Perlman

Byram Hills High School
New York

Brent Perlman, 17, of **Armonk**, engineered photosynthetic human cells that could produce their own oxygen for his Regeneron Science Talent Search **bioengineering** project. In plants, chloroplasts exposed to light make sugar and oxygen from carbon dioxide and water. Intrigued by the potential benefits of human cells that could produce their own oxygen, Brent pioneered a process to merge chloroplasts derived from organic baby spinach with human stem cells and observed that the cells naturally incorporated the chloroplasts. By measuring oxygen production with a specially calibrated sensor, he found that chloroplasts in the stem cells were able to conduct photosynthesis over an 11-day period with no apparent negative effects on the cells' metabolic activity. Brent believes his work could have implications in regenerating damaged tissues and advancing other areas of human health. At **Byram Hills High School**, Brent is president of the eNable club, which 3D-prints assistive devices for local students with cerebral palsy, and president of the Red Ribbon Club, which raises funds and awareness in the fight against HIV/AIDS. The son of Amy Stern and David Perlman, he is a tenor trombonist in New York All-State Ensembles.

2019 FINALISTS



Kevin Chengming Qian

Montgomery Blair High School
Maryland

Kevin Chengming Qian, 18, of **Rockville**, submitted a Regeneron Science Talent Search **physics** project that generalized results about making extremely accurate measurements of field-dependent quantities using quantum sensor networks. Fields are everywhere in physics, such as the Earth's gravitational or electromagnetic fields. Measuring quantities which depend on the strength of these fields at specific points in space is key. Kevin's work is in quantum metrology, a branch of physics that uses quantum phenomena to measure fields and related quantities more accurately than classical non-quantum sensors could alone. Previous work described measuring a linear sum of field values, but Kevin provided a much more general result by showing that similar ideas could be extended to analytic functions of field values. Further, Kevin demonstrated his scheme is asymptotically optimal. Kevin is a student at **Montgomery Blair High School** in Silver Spring where he participates in the school's math team and captains the physics and computer science teams. He has played the viola for over six years and contributes his talents to his local orchestra. Kevin enjoys participating in and organizing puzzle contests in his community. His parents are Feng Qian and Minglei Cui.

Ronak Roy

Canyon Crest Academy
California

Ronak Roy, 17, of **San Diego**, submitted a **bioengineering** project to the Regeneron Science Talent Search seeking to create an improved phoropter, a centuries-old, multi-lens machine used by eye doctors to gauge eyesight and prescribe glasses. To create his portable and inexpensive replacement, Ronak combined a smartphone with a voltage-controlled liquid lens. As the smartphone displays various images to the patient, the focal length of the liquid lens is changed by varying the voltage; the viewer indicates which settings are best. The final voltage setting, the one that provides the clearest vision, can then be used to determine the correct spherical eyeglass prescription. Conducting the entire software development process from home, and fabricating the housing on his homemade 3D printer, Ronak was able to create a working version of his patent-pending invention for a small fraction of the cost of a standard phoropter. Preliminary test results were promising. At robotics competitions and **Canyon Crest Academy** pep rallies, Ronak sometimes dons his team's narwhal mascot costume to fire up classmates and the crowd. In his free time, he develops and sells iPhone apps in the App Store. Ronak is the son of Latha and Protip Roy.

Eshika Saxena

Interlake High School
Washington

Eshika Saxena, 17, of **Bellevue**, submitted a Regeneron Science Talent Search **computer science** project that aimed to create an end-to-end blood disease screening process for rapid and automated disease identification. Building off her previous research on telemedicine and machine learning, Eshika first designed a 3D-printed smartphone attachment that converts the phone's camera to a microscope for documenting microscopic blood smears. She then created a unique database with over 7,000 images of blood cells and developed machine learning models to scan the database and identify a matching disease such as sickle cell with 95 percent accuracy. Committed to sharing her work, titled HemaCam, Eshika has released her code and database as open source software while also partnering with organizations in the "sickle belt" region of India for large scale field testing. Eshika founded and leads the artificial intelligence and machine learning club at **Interlake High School**. She is the daughter of Amrita and Parichay Saxena. Eshika has achieved a black belt in both Taekwondo and Arnis, enjoys playing the piano and co-founded a community organization inspiring and mentoring kids in STEM studies.

Ruhi Sayana

The Harker School
California

Ruhi Sayana, 17, of **Cupertino**, applied her Regeneron Science Talent Search **medicine and health** project to investigating the therapeutic potential of inhibiting certain proteins that regulate gene expression for treatment of hypodiploid B-ALL, an aggressive form of acute childhood leukemia. Ruhi first used in vitro methods to identify chemical compounds that selectively inhibit enzymes that are overexpressed in B-ALL. She then developed an algorithm to map links between the overexpressed enzymes and tumor suppressors to find those most relevant to progression and growth of this cancer. Her combined laboratory and computational methods revealed a drug with selective effects on cancer cells at low, clinically achievable concentrations. Ruhi's work may help advance targeted care for leukemia. Ruhi attends **The Harker School** in San Jose where she is research club president and content editor for *Harker Horizon*, a student-run research journal. She volunteers with local organizations tutoring students from low-income backgrounds and founded Girls in STEM at an underserved middle school in downtown San Jose. The daughter of Aparna and Raj Sayana, Ruhi is a classically trained singer who performs pieces in four languages.

2019 FINALISTS

Daniel Edwin Schäffer

Montgomery Blair High School
Maryland

Daniel Edwin Schäffer, 17, of **Silver Spring**, submitted a Regeneron Science Talent Search **genomics** project that sought to explain the origins of important intracellular machinery, with implications for both evolution and the treatment of Wolfram syndrome, a rare genetic illness. Daniel developed a rigorous computational scheme to examine the relationships among proteins that manage intracellular calcium and traced their genetic distribution in 41 different taxonomic groups. Through phylogenetic analysis of these proteins, Daniel was able to demonstrate parallels in the evolutionary process of calcium signaling with other similar intracellular systems. He believes that his results support the idea that calmodulin, an important calcium signaling protein, originated in primordial cyanobacteria that populated calcium-rich environments. Daniel's investigation also provided new details about the structure of the protein mutated in most cases of Wolfram syndrome, and he hopes his work will spur additional research on this rare disease. In addition to his scientific activities, Daniel is the director of horticulture for the Green Club at **Montgomery Blair High School**. His parents are Alejandro and Beth Schäffer.

Justin D. Schiavo

Roslyn High School
New York

Justin D. Schiavo, 18, of **Roslyn Heights**, submitted a Regeneron Science Talent Search **engineering** project describing a hybrid rocket engine that he built in hopes of making space travel more affordable and available to more people. Hybrid rocket engines, which can be made with materials from a hardware store, were developed in the 1950s and typically designed with a bell-shaped nozzle that sometimes failed to deliver sufficient power to launch a rocket into space. Justin designed an improved aerospike nozzle with more thrust, had several 3D-printed in copper and conducted multiple ignition tests in a lab. His new nozzle melted in its first test, but Justin found success in later tests after redesigning it with improved cooling. His work suggests that hybrid engines with aerospike nozzles are a viable option for affordable access to space. A senior at **Roslyn High School**, Justin is president of the astronomy club, where he increased membership to over 50 active star gazers, and he is a long-distance runner for the cross country and track teams. Justin is also a student pilot and has volunteered at the Cradle of Aviation Museum, teaching visitors about the history of spaceflight on Long Island. His parents are Monelle and Michael Schiavo.

Rachel Seevers

Paul Laurence Dunbar High School
Kentucky

Rachel Marie Seevers, 17, of **Lexington**, developed a more efficient aircraft wing for her Regeneron Science Talent Search **engineering** project. Rachel used model aircraft in a wind tunnel and a flow tank that she built in her basement, along with computational fluid dynamics simulations, to test her theories. Her five-year research project into airfoil design led to the development of the Virtual Winglet. By ejecting high-speed air at the leading edge of the underside of the wingtip, her Virtual Winglet suppresses wingtip vortices and improves airflow over the wing surface, enhancing the stability and efficiency of an aircraft. Rachel believes her invention can improve the lift-to-drag ratio of an average military aircraft by 26 percent and prevent 112 million tons of carbon dioxide emissions every year. She hopes to soon see her invention tested in flight. She is president of the French club, co-founder of Dunbar Girls in STEM and a member of the advanced chamber choir at **Paul Laurence Dunbar High School**. To earn her Girl Scouts Gold Award, Rachel is launching several STEM outreach programs. The daughter of Denise and Kenneth Seevers, she is now studying submarines and dreams of one day becoming Secretary of Defense.

Aditi Singh

Horace Greeley High School
New York

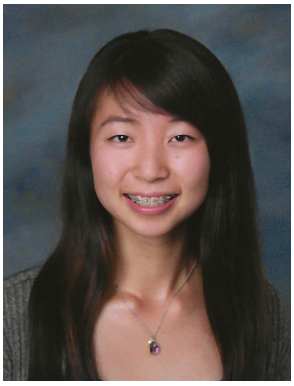
Aditi Singh, 17, of **Chappaqua,** developed a computational model suggesting that visual short-term memory may be both a rational cost-benefit choice and an intrinsically limited human resource for her Regeneron Science Talent Search **behavioral and social sciences** project. While it is known that as more items are held in memory each is recalled with reduced precision, Aditi created a model of memory recall to explore the nature of these limitations. She applied her model to an earlier study in which she found that subjects' recall of previously seen colors deteriorated sharply as the number of stimuli, similarity of color choices and other "noise" increased. Her normative model assumes the brain is making a rational decision to use less precision in an effort to minimize the neural effort, or "cost," of recall. Her work may lead to better understanding of neurological disorders and other areas where memory function is key. Aditi attends **Horace Greeley High School** where she is editor-in-chief of the school newspaper and vice president of the creative writing club. The daughter of Mamta Singh and Shiv Kumar, Aditi also teaches English to non-native speakers in her community.

2019 FINALISTS

Amol Singh

Lynbrook High School
California

Amol Preet Singh, 18, of **San Jose**, submitted a **computational biology and bioinformatics** project to the Regeneron Science Talent Search seeking to improve the digital imagery of stained cytology slides. Many current digital pathology systems capture images of these slides but the results appear only two-dimensional, even though some images, such as of solid tumors, are more complex with features that closely resemble valleys and mountains. Amol's STAC-STIC software adapts slow-motion video microscopy data into extremely high resolution 3D pathology images. These super-resolved panoramic images of stained tissue slides may enhance the ability of researchers and physicians to make more informed diagnoses, perform downstream computational analyses and collect data. At **Lynbrook High School** Amol heads the Model UN and the environmental impact club. The son of Rupinder Kaur and Baltej Singh, Amol is the first author of a paper on his research subject published in the *Journal of Pathology Informatics*. Inspired by his computational research, and after seeing members of his family suffer from diabetes, he established and heads a consulting company that helps clients use an artificial pancreas system.



Julia Situ

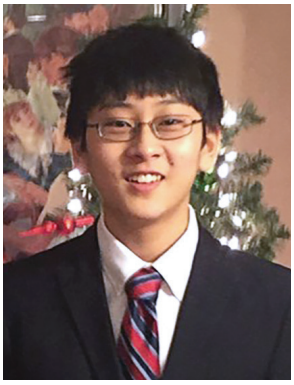
Canyon Crest Academy
California

Julia Situ, 18, of **San Diego**, focused her Regeneron Science Talent Search **cellular and molecular biology** project on the role of a new class of circular, non-coding regulatory RNAs in innate immunity, which is critical to human health and survival. Julia used deep sequencing to identify circRNAs in embryonic and live fruit flies, introduced bacterial infection and proceeded to overexpress or delete circRNAs to observe any impact on the Immune Deficiency (IMD) pathway that helps govern the ability of fruit flies to fight off infection. Her results revealed select circRNAs positively regulate innate immunity in fruit flies and take on roles in neuron and muscle function. Because the IMD pathway has been linked to neurodegeneration in fruit flies, Julia's work could inform treatment of similar diseases in human patients. Julia attends **Canyon Crest Academy**, where she was vice captain of the 2018 CIF Champion tennis team, co-founded her school's Leukemia and Lymphoma Society club and is co-president of the STEM-related club Young Leaders in Healthcare. An award-winning pianist and a member of Toastmasters International, she is the daughter of Zhe Nie and Longshou Situ.

Madhav Subramanian

Jericho Senior High School
New York

Madhav Subramanian, 18, of **Jericho**, submitted a Regeneron Science Talent Search **cellular and molecular biology** project studying angiogenesis, the body's formation of new blood vessels, and how it relates to cancer tumor growth. Madhav sought to starve tumors to stifle their growth and metastasis. He began by seeking to identify the role of the ETM* gene in endothelial cells and assess its potential as a target to prevent the growth of cancerous tumors. He observed that cells without ETM* had impaired proliferation, migration, sprout formation and tube formation, suggesting that ETM* does regulate angiogenesis. His work further suggests that therapy targeting ETM* could curtail the life-threatening progression of several cancers. Madhav was inspired to study the self-repair mechanism of angiogenesis following painful treatment for a knee injury. At J**ericho Senior High School**, Madhav leads all three Science Olympiad teams and played soccer until his knee was damaged in a game. His parents are Subramanian Kunchithapatham and Anasuya Thammineni. A volunteer at a local hospital, he visits older patients and organized students in the French Honor Society to make get well cards and origami.



William Wang

Oklahoma School of Science & Mathematics
Oklahoma

William Wang, 17, of **Tulsa**, created nanometer-sized europium-doped yttrium oxide materials that could improve the performance of LEDs for his Regeneron Science Talent Search **materials science** project. Unlike previous researchers, who had mostly created particles in the sub-100 nm range, William identified methods to create larger nanospheres, as well as nanosheets and nanotubes. In doing so, he determined an optimal mix of reagents and methods for creating these materials. He then characterized the properties of these nanomaterials and found that the emission properties of the nanospheres with a cubic crystal structure exhibited a strong red luminescent emission, which suggests that they could be used as red phosphors that could be combined with blue/ultraviolet LEDs to generate a high-quality white light. The emission spectra of the nanosheets indicate that they also might be useful in enhancing the efficiency of ordinary white light LEDs. The son of Sanwu Wang and Mei Wu, William has won numerous awards for his piano expertise at the state and local levels. He has also managed a youth music tour that performed at senior centers. He attends the **Oklahoma School of Science and Mathematics** in Oklahoma City.

2019 FINALISTS

Zoe Weiss

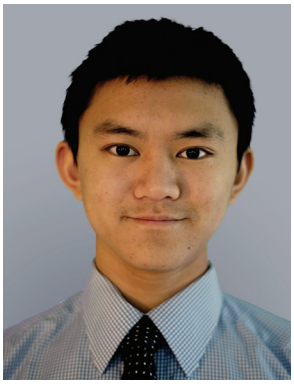
Lakeside High School
Georgia

Zoe Weiss, 17, of **Atlanta**, created an algorithm to detect rare cell types from single-cell gene expression data that could be key to early disease diagnosis for her Regeneron Science Talent Search **computational biology and bioinformatics** project. Without data from an ample number of genes, state-of-the-art computational methods fail to detect rare cells, such as a circulating tumor cell among the millions of cells in an otherwise normal blood sample. Zoe overcame these limitations by developing and then validating computational methods for detecting rare cells on increasingly complex sets of animal and human single-cell gene-expression data, including a set impervious to current methodology. Her resulting algorithm was in all cases able to detect rare cells, one of which could prove to be a new type of hippocampal brain cell. Zoe's work may enable earlier diagnosis of diseases and new insights into cell differentiation. Zoe plays varsity soccer, runs cross country, and organized the first TEDx event at **Lakeside High School**. She interns at Emory University and is founder and editor-in-chief of a DeKalb County school district science journal. The daughter of Lora and Howie Weiss, Zoe also loves to hike, kayak, and ski.

Samuel Weissman

Harriton High School
Pennsylvania

Samuel Weissman, 17, of **Merion Station**, studied the genetic makeup of HIV infected immune cells for his three-year Regeneron Science Talent Search **cellular and molecular biology** project. Patients treated for HIV with anti-retroviral therapy (ART) continue to have "reservoirs" of treatment-resistant HIV infected cells even after years of treatment. To better understand the reservoir, Sam analyzed the genetic makeup of HIV in two patients on ART over time. HIV replicates in two ways: by expression, releasing virions to infect other cells, or by clonal expansion, duplicating its DNA when infected cells divide. Sam found that the immune system slowly kills HIV infected cells of the reservoir, but they persist by clonal expansion. His research also suggests that HIV can enhance clonal expansion by stimulating genes that increase cell division — a process that may be key to reservoir persistence. Sam is a member of the Science Olympiad team at **Harriton High School** in Rosemont. He also plays saxophone and is a Writing Center Fellow who enjoys helping others find their literary voice. The son of Beth Rosenwasser and Richard Weissman, Sam created an app for behavioral therapists to track patient behavior and model reinforcement.



Frank Z. Xu

Brookline High School
Massachusetts

Frank Z. Xu, 17, of **Brookline**, researched the role two enzymes play in the development of polycystic kidney disease (PKD) for his Regeneron Science Talent Search **biochemistry** project. PKD is a life-threatening genetic disease in which the kidney interior degenerates into cysts, leading to eventual renal failure. Frank found that a complex of two enzymes that break down proteins contribute to the damage. Abbreviated as ADAM10 and MMP14, these enzymes slice off large fragments of a major cell membrane protein (E-cadherin) causing cells to lose their shape. He also noted that inhibiting the ADAM10-MMP14 complex restores normal cell shape and blocks the development of cystic growth patterns. Frank believes that, after proper testing, we might find a treatment for PKD among the currently available ADAM10-MMP14 inhibitors. Because the enzymes are also involved in Alzheimer's disease and tumor metastasis, fine tuning the ADAM10-MMP14 interaction could lead to advances in treating these and other diseases. Frank attends **Brookline High School** where he runs cross country and is captain of the biomedical research club. The son of Dawson Xu and Tianqing Kong, he is a U.S. National Chemistry Olympiad qualifier.

Madeleine L. Yang

Detroit Country Day School
Michigan

Madeleine L. Yang, 17, of **Bloomfield Hills**, submitted a Regeneron Science Talent Search **bioengineering** project seeking a means of flu vaccine production superior to current methods that use eggs from chickens. Every year, influenza virus infections cause hundreds of thousands of deaths worldwide. One approach to improving the production and efficacy of flu vaccines is through the use of engineered but non-infectious virus-like particles (VLPs) that introduce viral proteins, such as flu protein M2, to the immune system. Unfortunately, M2 expression causes the death of cells used for VLP production. Based on previous studies showing that the M2 inhibitor amantadine prevented this cell death, Maddie cultured cells in amantadine and dramatically increased their VLP yield. Her work may lead to the development of a universal vaccine for viral influenza. At **Detroit Country Day School** in Beverly Hills, Maddie is a varsity sailor and editor-in-chief of the science journal *Eureka*. She is an accomplished musician, with solo competition experience at Carnegie Hall. The daughter of Mei Li and Jun Yang, Maddie has travelled to northern China for five years to teach math to elementary school students from minority communities there.

REGENERON SCIENCE TALENT SEARCH 2019 | Finalists by State

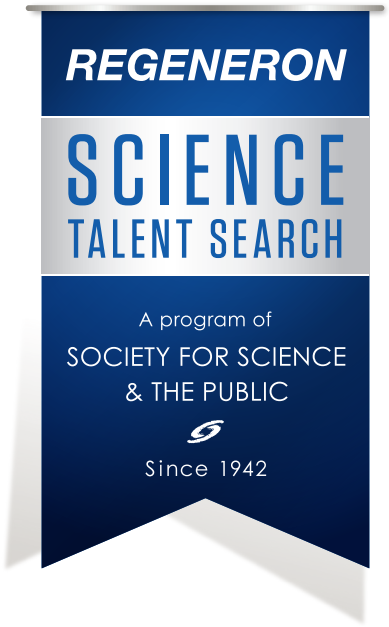
REGENERON SCIENCE TALENT SEARCH 2019 | Finalists by Last Name

SOCIETY FOR
SCIENCE & THE PUBLIC

About Society for Science & the Public

The Society for Science & the Public is a champion for science, dedicated to expanding scientific literacy, effective STEM education and scientific research. Founded in 1921, we are a nonprofit 501(c)(3) membership organization focused on promoting the understanding and appreciation of science and the vital role it plays in human advancement. Through its acclaimed science research competitions, including the Regeneron Science Talent Search, the Intel International Science and Engineering Fair and the Broadcom MASTERS, and its award-winning magazine, *Science News* and digital media properties, *Science News for Students*, the Society is committed to inform, educate and inspire.

Learn more at:
www.societyforscience.org
and follow us on
Facebook **https://www.facebook.com/societyforscience**
Twitter **@Society4Science**
Instagram **@Society4Science**
Snapchat **Society4Science**



About Regeneron

Regeneron is a leading biotechnology company that invents life-transforming medicines for people with serious diseases. Founded and led for 30 years by physician-scientists, our science-driven approach has resulted in seven FDA-approved medicines and numerous product candidates, all of which were homegrown in our laboratories. Our medicines and pipeline are designed to help patients with eye diseases, allergic and inflammatory diseases, cancer, cardiovascular and metabolic diseases, neuromuscular diseases, infectious diseases and rare diseases.

We work to accelerate and improve the traditional drug development process by developing groundbreaking technologies and conducting ambitious research, including one of the largest genetic sequencing efforts in the world.

We believe that scientists should be the world's heroes and are committed to fostering the next generation of scientific talent through STEM (Science, Technology, Engineering, Math) education and equity efforts. Our STEM programs include the Regeneron Science Talent Search, a program founded and produced by Society for Science & the Public, which has been developing the nation's young scientific talent and fostering future innovators since 1942. In 2016, Regeneron committed $100 million over 10 years and became only the third title sponsor in the competition's storied 78-year history, following in the footsteps of previous title sponsors Westinghouse and Intel. In addition to the Regeneron Science Talent Search, we support many local and national initiatives with a focus on creating education pathways to careers in STEM, cultivating the best and brightest minds in science research and addressing STEM opportunity gaps for students historically underrepresented in the sciences.

Learn more about our programs at:
www.regeneron.com/scienceeducation
and follow us on
Facebook **www.facebook.com/Regeneron**
Twitter **@Regeneron**
Instagram **@Regeneron**

Society for Science & the Public
1719 N Street, NW
Washington, DC 20036-2801
202.785.2255 telephone
sts@societyforscience.org
student.societyforscience.org/regeneron-sts