REGENERON

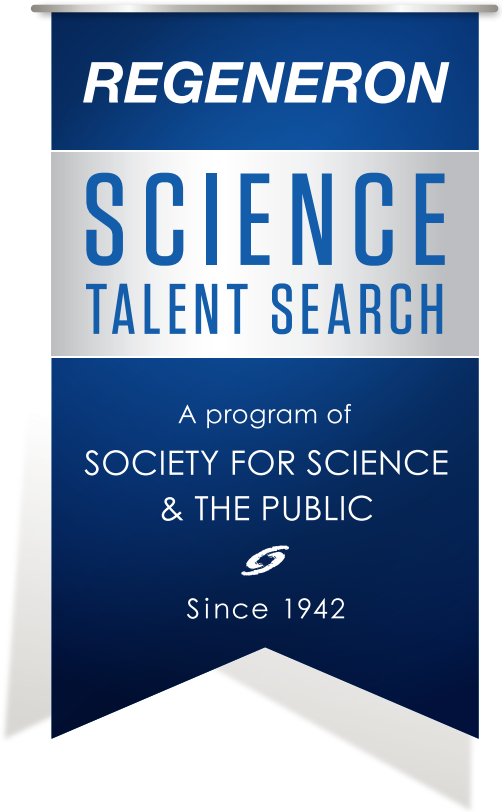
SCIENCE
TALENT SEARCH

A program of
SOCIETY FOR SCIENCE
& THE PUBLIC

Since 1942

REGENERON SCIENCE TALENT SEARCH

2018 FINALISTS



2018 FINALISTS

The Regeneron Science Talent Search (Regeneron STS), a program of Society for Science & the Public, is the nation's most prestigious science and mathematics 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 2018

MARCH 8–14, 2018

The 40 finalists of the Regeneron Science Talent Search 2018, 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 31 schools in 15 states. Finalists were selected from more than 1,800 entrants representing 555 high schools in 45 states, the District of Columbia, Puerto Rico and six overseas schools.

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 2018 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 2018 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 23,271 finalists and scholars who have received $22 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 Museum of Women in the Arts, 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 13.

Each of the 300 students named a scholar in the Regeneron STS 2018 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 2018. The award is used to advance excellence in science, math, and/or engineering education at the recipient school.

2018 FINALISTS

Sidhika Balachandar

Buchholz High School
Florida

Sidhika Balachandar, 18, of **Gainesville**, developed a method to measure strain at the atomic scale in superconductors for her Regeneron Science Talent Search **physics** project. Sidhika used a scanning tunneling microscope to observe tiny (nanometer-scale) changes on the surfaces of superconductive materials in terms of atomic-scale compression or stretching. This is important because some materials can become superconductors or lose superconductivity when exposed to such strains. Sidhika developed a way to mathematically manipulate the measured surface changes in order to calculate the various amounts and types of strain. She also created a method to verify the viability of her approach. She has also co-authored a paper published in the *Materials Research Society Bulletin*. Sidhika is an accomplished flautist whose flute ensemble performs at local assisted living homes. She also performs the South Indian classical dance form Bharatanatyam, which she has studied for over a decade. Sidhika volunteered as a math and English teacher at a school in India while traveling with her parents, Uma Krishnan and Siva Balachandar. Sidhika attends **Buchholz High School** and is a head teacher for the school's math summer program.

Reese Caldwell

Conestoga High School
Pennsylvania

Reese Caldwell, 17, of **Devon**, submitted a Regeneron Science Talent Search **bioengineering** project focused on expanding the utility of synthetic cells by developing a method to control their inner workings with a pulse of light. The "synthetic cells" that Reese used have a lipid membrane and contain protein systems, similar to living cells, which is why they are used by scientists to study the fundamental biochemical processes of living systems. Achieving real-time control of these processes in synthetic cells remains challenging, prompting Reese to pair light-sensitive ligands to several proteins frequently studied in synthetic biology. He then demonstrated the ability to stimulate enzymatic activity and protein activation through light stimulation. Reese believes his work may permit deeper studies into the relationship between protein activity and cell morphology. He attends **Conestoga High School** in Berwyn, where he is co-president of the biology club and a state-level Science Olympiad gold medalist. Reese was also a regional champion of the Pennsylvania Governor's STEM Competition, for which he led a team designing a wristband capable of alerting deaf wearers to emergency alarms. His parents are Mike and Debra Caldwell.

Maggie Shin-Young Chen

Canyon Crest Academy
California

Maggie Shin-Young Chen, 18, of **San Diego**, submitted a **bioengineering** project to the Regeneron Science Talent Search with the goal of eliminating superbugs without the need for antibiotics. She began by researching the composition of bacterial toxins commonly found in MRSA and *E. coli* that destroy red blood cells. She then took the creative step of using nanoparticles camouflaged as red blood cells in a hydrogel to sequester the toxins. Maggie tested hydrogel channels of varying shapes to optimize blood flow and enhance detoxification. Her resulting nanodevice can be 3D printed very quickly and may, one day, lead to a low-cost, patient-specific treatment for certain bacterial infections. She is first author of a paper about her work published in *Nanoscale*. At **Canyon Crest Academy**, Maggie is editor-in-chief of the science magazine. An accomplished clarinetist and pianist, she has twice won piano competitions at Carnegie Hall, and toured with the San Diego Youth Symphony China Tour Orchestra. Maggie, whose mother is Wei Wei, hopes to see a day when nanobots inside the human body deliver therapeutic drugs as cell-specific cancer treatments.

Andrew Fang

Jericho Senior High School
New York

Andrew Fang, 17, of **Jericho**, investigated artemisinin (ART), a compound derived from the sweet wormwood plant, as a potential treatment for Parkinson's disease (PD) for his Regeneron Science Talent Search **medicine and health** project. Current treatments for PD address its symptoms, but not its progression. Artemisinin, originally used to treat malaria, has demonstrated the ability to diminish inflammation and improve neuron function in other diseases. Andrew tested ART on neurons damaged by α-synuclein (αS), the protein responsible for PD, and found that ART mitigated αS-induced neuronal changes. He also conducted *in vivo* research on fruit flies with PD and found that ART was able to improve both their survival and locomotion. He believes that further research on ART is warranted to confirm its potential to treat PD. Andrew is president and founder of the MIT Launch chapter, a start-up incubator, at **Jericho Senior High School**, where he is also a member of the Science Olympiad team and Future Business Leaders of America. The son of Yixin Fang and Sulan Wang, Andrew shares his love for music by playing piano for residents of a retirement home. He hopes to pursue a career in pharmacology and develop treatments for neurodegenerative diseases.

2018 FINALISTS

Ella Feiner

Horace Mann School
New York

Ella Rose Feiner, 18, of **Ridgewood, New Jersey,** explored the relationship between cell division and cell migration for her Regeneron Science Talent Search **cellular and molecular biology** project. Studies suggest that metastasis, the spread of cancer from its place of origin, may only be possible when cellular division ceases during periods of cell cycle arrest, which can occur during treatment with certain cancer drugs. To explore this, Ella adapted a special cell-cycle sensor to examine the effect of forced cycle arrest on the development of zebrafish embryos treated with cancer drugs. During early embryonic development, primitive structures are naturally formed by invading cells in an arrested state. Ella observed that inducing cell cycle arrest led more cells to become invasive, supporting a relationship between cell cycle arrest and metastasis. In addition to her accomplishments in the lab, Ella is a varsity swimmer, co-president of the Science Olympiad team, co-founder of Girls in STEM and co-president of the debate team at **Horace Mann School** in the Bronx, N.Y. Ella also was named top speaker, of more than 400, at the 2016 Yale Invitational. The daughter of Drs. Shoshana and Leonard Feiner, she is an accomplished pianist and volunteers as a debate team coach at a middle school in the Bronx.

Benjamin J. Firester

Hunter College High School
New York

Benjamin Jacob Firester, 18, of **New York,** developed a model to predict how disease data and weather patterns could spread spores of the "late blight" fungus that caused the Irish Potato Famine for his Regeneron Science Talent Search **plant sciences** project. Currently, the only protection against late blight is to preemptively douse all potato crops with fungicide. Benjy spent two summers at a research facility in Israel, and the year in between at home, developing a new predictive model. Using mathematical graph theory, his model takes straightforward input data – existing blight locations, date, time, and detailed local weather data – to model the likely routes by which late blight spreads and to predict the most likely future infection sites. Benjy believes that farmers could someday share infection data and use his model to assess risk and reduce the unnecessary use of fungicide. Benjy attends **Hunter College High School** where he competes on the math team and is a volunteer math tutor. Beginning piano studies at age four, Benjy has performed in chamber ensembles at Lincoln Center and as a soloist in Carnegie Hall. The son of Ruth and Jon Firester, Benjy aspires to study math, computer science, physics, and economics, and earn a doctorate.

Kyle Oskar Fridberg

Fairview High School
Colorado

Kyle Oskar Fridberg, 17, of **Boulder,** discovered a new compound that may prove useful in improving rechargeable battery technology for his Regeneron Science Talent Search **chemistry** project. One day while biking, Kyle found an unusual vein in a rock face along the side of the road. He took a sample home to his garage lab, dissolved it in sulfuric acid to identify its composition, and obtained solutions of red or purple, which were unexpected. That finding led to a year-long effort to identify the red/purple compound he had produced. Kyle developed specialized purification and crystallization procedures, which allowed him to identify the compound as a new substance, hydrogen ferric manganic sulfate (HFMS). He then devised an easily reproducible method to synthesize HFMS using a household microwave oven. The composition and layered crystal structure of HFMS show promising potential for synthesis of safer and more cost-effective cathodes for lithium-ion batteries. The son of Robyn Tighe and Jan Fridberg, Kyle attends **Fairview High School** where he has earned awards in chemistry and history. He also sings in a men's choir and is a nationally ranked rock climber.

Sarah Gao

Montgomery Blair High School
Maryland

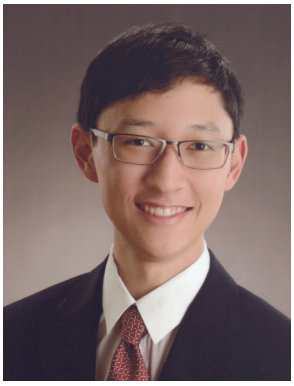
Sarah Gao, 17, of **Silver Spring**, identified enzymes that appear to kill a Gram-negative, antibiotic-resistant bacterium responsible for about 10 percent of all hospital-acquired infections, for her Regeneron Science Talent Search **cellular and molecular biology** project. Previous researchers had isolated enzymes from bacteriophages (viruses that infect bacteria) that are able to destroy drug-resistant Gram-positive bacteria but are unable to penetrate the outer membranes of Gram-negative bacteria. Sarah isolated and purified four enzymes from bacteriophages that she had previously characterized as able to kill these bacteria, and showed that these enzymes could rupture the bacteria's outer membrane, even without the use of agents to make the membrane permeable. Her work may contribute to improved therapeutics for antibiotic-resistant Gram-negative bacterial infections. The daughter of Lianyong and Guozhen Gao, Sarah is first author of a 2017 paper published in the peer-reviewed journal, *Genome Announcements*. Sarah attends **Montgomery Blair High School** where she performs in musical theater productions, sings first soprano in the Chamber Choir and plays piano accompaniment for the Show Choir.

2018 FINALISTS

Louis Golowich

Lexington High School
Massachusetts

Louis Zeger Golowich, 17, of **Lexington**, created random number generators (RNGs) for multithreaded programs (programs that perform multiple operations simultaneously) as his Regeneron Science Talent Search project in **computer science**. Many computing applications require the use of random numbers, but the random numbers typically produced by an RNG are, statistically, only very close to random – not good enough for some scientific or high-security work. In addition, many RNGs now used in multiprocessing environments are slow, of limited applicability or have statistical deficiencies. Louis addressed these issues by developing two new deterministic RNGs for multithreaded programs that performed well on standard statistical tests, are as fast as existing generators and result in numbers with improved properties for randomness. Louis credits his project with teaching him the challenges of engineering a tool for solving real problems. Louis is the son of Linda Zeger and Steven Golowich. He attends **Lexington High School** where he is captain of the math and computer science clubs. A three-year varsity tennis player, Louis completed his junior year undefeated, finishing with a streak of nine winning matches.



Davey H. Huang

Iolani School
Hawaii

David Hideo Huang, 18, of **Honolulu**, created software designed to detect certain birth abnormalities during early development of *in vitro* fertilization (IVF) embryos for his Regeneron Science Talent Search **cellular and molecular biology** project. Davey says, "I exist because of IVF." Working from home, he sought a visual way to identify developing embryos that exhibit signs of aneuploidy, which is the presence of an abnormal number of chromosomes. Aneuploidy can cause developmental disorders such as Down syndrome. Davey's research examined time-lapse videos of developing embryos using machine learning software that he wrote; his resulting model identified aneuploidy with good accuracy. He hopes that by facilitating early identification of aneuploid embryos, his model might reduce the number of failed implantations, miscarriages or babies with genetic illnesses. Davey attends **Iolani School** where he leads both Science Olympiad and Science Bowl teams and plays doubles for the school's state champion varsity tennis team. His parents are Thomas and Satomi Huang, and although he has won multiple awards in science and piano, he says "painting is a relaxing way to escape into my imagination."

Charley Hutchison

St. Andrew's Episcopal School
Mississippi

Charles Hutchison, 17, of **Jackson**, studied how fluctuations in heat and other forms of energy affect the rate at which molecules return to equilibrium in supercooled liquids for his Regeneron Science Talent Search **chemistry** project. While molecular response rates are known to slow in liquids carefully brought below the freezing point without forming crystals, Charley sought deeper insight into the kinetics of supercooled liquids. Specifically, he explored how changes in temperature and electric fields alter the time required for a region of these molecules to resume equilibrium. His subsequent model shows how the thermodynamic properties of a supercooled liquid control its molecular kinetics, which may have applications in food processing, pharmaceuticals and other industries that use supercooled liquids. Charley attends **St. Andrew's Episcopal School** in Ridgeland where he leads both Latin Club and the Quiz Bowl team. Over the past four years, he has served on the Youth Ambassador Council for the Mississippi Children's Museum. Charley placed first for organic chemistry in regional and state competitions at the 2017 Mississippi Science and Engineering Fair. An Eagle Scout, Charley is the son of Robert and Melissa Hutchison.

Skyler Chloe Jones

Ossining High School
New York

Skyler Chloe Jones, 17, of **Ossining**, identified key aspects of perovskite crystals that may lead to the development of more effective, less expensive solar cells for her Regeneron Science Talent Search **chemistry** project. One obstacle to widespread solar energy usage is the production cost of solar cells. Perovskite, which refers to any material that has the same crystal structure as calcium titanium oxide, has unusual optical and electronic properties that make it a very efficient semiconductor. Skyler determined the property of perovskite's atomic structure that makes it so effective, despite its structural defects and low stability. If these properties were replicated in a semiconductor crystal that is more structurally stable than perovskite, the efficiency of the new semiconductors would not depend on structural purity, which could reduce production costs. Skyler, the daughter of Jennifer and Colin Jones, is co-author of a paper published in the journal, *Science Advances*. Skyler attends **Ossining High School** where she is a member of the varsity track and swim teams. She works at the Ossining Library in the children's section and co-captains the Relay for Life team, a fundraiser for the American Cancer Society.

2018 FINALISTS

Andrew Komo

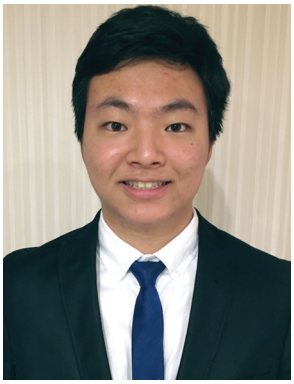
Montgomery Blair High School
Maryland

Andrew Komo, 17, of **Bethesda**, delivered a new cryptography protocol for use in complex very large-scale online auctions, such as those for electricity and telecommunications spectrum, for his Regeneron Science Talent Search **computer science** project. When an auction is selling numerous items and dealing with multiple simultaneous bidders, the software managing the transactions must have sufficient security to hold both bidders and auctioneers to fair auction rules without sacrificing privacy. Andrew created a protocol for these large-scale auctions that involves two cryptographic techniques, resulting in a system that vets incoming bids, maintains privacy for all parties and is efficient and easy to use. A lifelong enthusiast of economics and cryptography, Andrew notes that while cryptographic mechanisms drove his project design, his work is rooted in a practical and thoroughly economic foundation. At **Montgomery Blair High School** in Silver Spring, he captains both the economics club and computer team and plays varsity tennis. He also helped organize an annual cybersecurity competition at his school that hosted nearly 1,500 participants last year. Andrew is the son of Stella Grosser and Scott Komo.

Kavya Kopparapu

Thomas Jefferson High School for Science and Technology
Virginia

Kavya Venkata Kota Kopparapu, 17, of **Herndon**, developed a deep learning tool that aims to rapidly provide tumor information in patients with glioblastoma, the most common form of adult brain cancer, for her Regeneron Science Talent Search **computational biology and bioinformatics** project. In an effort to reduce the typically over two-week post-diagnostic treatment pipeline for this highly aggressive cancer, Kavya integrated cell biology and image processing in a data-driven system of neural networks that can extract relevant tumor information solely from scanned images of cell biopsies. Her patented assessment platform, GlioVision, identified tumor features, molecular subtypes and expression status of genes with high degrees of accuracy in five seconds, potentially expediting the specificity of patient targeted treatment decisions. Kavya attends **Thomas Jefferson High School for Science and Technology** in Alexandria where she leads the Bioinformatics Society and Russian Language and Culture Club, which she co-founded. Kavya is a Cessna pilot-in-training and CEO of GirlsComputingLeague, a group that she established to help close the gender gap in computer science. Her parents are Rajani and Madhu Kopparapu.



Chiu Fan Bowen Lo

Jericho Senior High School
New York

Chiu Fan Bowen ("Leo") Lo, 18, of **Jericho**, developed a novel simulation method to assess scattering-type scanning near-field optical microscopy (s-SNOM) for his Regeneron Science Talent Search **physics** project. By using a probing tip to measure nanoscale optical properties, s-SNOM can circumvent the diffraction limit of conventional optics and provide chemical contrast imaging at the nanometer scale. Leo developed a simulation to analyze these tips and more effectively represent the shape, angle of incidence and signal extraction method. His simulation, which was tested with silica, sapphire and gold nanostructures, produced higher resolution images and more accurate modeling results than conventional methods and may have applications in nano-device development. Leo is a student at **Jericho Senior High School** where he co-founded the physics team, serves as co-president of a peer tutoring club and is principal flute and flute section leader of both the symphonic and marching bands. He also volunteers as an editor for a local newspaper that translates news stories into Chinese for the Chinese American community. The son of Kam Ching Tso and Ming Kui Lo, he co-authored a paper exploring s-SNOM published in *Applied Physics Letters*.

Michael Yuanchao Ma

Plano West Senior High School
Texas

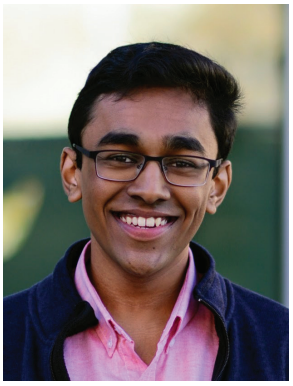
Michael Yuanchao Ma, 18, of **Plano**, used combinatorics to give new insights and generalize an important permutation pattern theorem for his Regeneron Science Talent Search **mathematics** project. Using a computer program he wrote, Michael collected data on the number of non-trivial equivalence classes of various permutation patterns and pattern replacements. His results enabled him to disprove a previously published mathematical conjecture and to formulate a more sophisticated version of it. Further, Michael was able to generalize the mathematically famous Erdős-Szekeres Theorem, extending it to have meaning in the context of permutation pattern-replacement equivalences. These relationships can be used by mathematicians to understand common algebraic structures, and have potential applications in computer science as well as in automatic code optimization theory. Michael is the son of Xinshi Zhou and Wenhua Ma and attends **Plano West Senior High School**, where he is an active member of the math club. Every year in high school, he has qualified for the Mathematics Olympiad Summer Program. Michael earned a perfect score as well as a gold medal at the 2017 Asian Pacific Mathematics Olympiad.

2018 FINALISTS

Rohan Mehrotra

Lynbrook High School
California

Rohan Mehrotra, 17, of **Saratoga,** studied a nanotechnology-based drug delivery system for his Regeneron Science Talent Search **chemistry** project. Targeted drug delivery has been an elusive goal in medicine. While thousands of stimuli-responsive drug delivery systems (DDS) have been developed, none have reached clinical use, largely because they are not biocompatible. Rohan developed a biocompatible, resorbable, organic nanofilm composed of a "smart" material, Eudragit S100 (EGT), that can be loaded with a drug. When a weak electric field is applied to this nanofilm, the EGT becomes soluble and releases the drug. Rohan believes he can control the dosage of the DDS by varying the applied voltage. He attends **Lynbrook High School** in San Jose where he is co-leader, with his twin sister, of STEMinars, a mentorship resource, and vice president of the neuroscience club. Captivated by the movie "Moneyball," Rohan helped start Lynbrook Sports Analytics Club. He also volunteers in the emergency room of a local hospital. The son of Pallavi and Sharad Mehrotra, Rohan is a first-degree black belt in Karate and co-first author of an article based on his research published in the journal, *Nanoscale*.



Rajiv Movva

The Harker School
California

Rajiv Movva, 18, of **San Jose**, submitted a **computational biology and bioinformatics** project to the Regeneron Science Talent Search that examined how noncoding DNA impacts gene expression in chronic disease. The human genome contains a large amount of DNA that does not directly code for protein. Over 90 percent of disease-causing mutations arise in this "noncoding" region, and can lead to aberrant gene activation that causes illness. Rajiv's artificial intelligence-based method, called SNPpet, is a convolutional neural network trained on large genomic datasets that tries to predict how DNA mutations affect gene expression. Current methods focus on protein variants, which may not catch all regulatory mutations. Rajiv successfully used SNPpet to identify markers for heart attack risk, and believes his model could one day contribute to personalized diagnoses and treatments. At **The Harker School**, Rajiv is president of the research club and helps manage *Harker Horizon*, a student-run research journal. He also volunteers as a middle school math team coach. Rajiv, son of Leela and Prasad Movva, presented some of his work at a 2015 invitation-only White House conference on career preparedness for high school students.

Chythanya Murali

Centennial High School
Maryland

Chythanya (Chy) Murali, 17, of **Ellicott City**, conducted experiments targeting leukemic cancers using immunotherapy for her Regeneron Science Talent Search **bioengineering** project. Motivated by her grandfather's struggle with cancer, Chy developed a target-specific cancer treatment using one of the components of the human immune system, the natural killer (NK) cell, while eliminating some side effects associated with immunotherapy. She modified NK cells to express receptors that improve their specificity for tumor cells, then combined them with an antibiotic to enhance anti-tumor activity and limit NK over-proliferation. Her modified immunotherapy not only retained appropriate control when targeting tumor cells but also showed potential for reducing excessive proliferation of NK cells that can be a harmful side effect of immunotherapeutic treatment. Chy's work may contribute to more effective cancer remedies. At **Centennial High School**, Chy is co-editor-in-chief of the math journal and co-leader of the Salvation Army club and Science Olympiad team. The daughter of Murali Elambilan and Vineetha Edavana, Chy is president of Ellicott City Tutors, for which she organizes training efforts at local middle and elementary schools.

Natalia Orlovsky

Garnet Valley High School
Pennsylvania

Natalia Dmitrievna Orlovsky, 18, of **Chadds Ford,** submitted a study on the effects of vaping on lung epithelial cells as her Regeneron Science Talent Search project in **cellular and molecular biology**. Inspired by the scientific work of a friend and promotional literature that represents vaping as a safer alternative to conventional smoking, Natalia examined the response of lung cells to e-cigarette vapor condensates (called e-liquids) of varying flavor and nicotine content. Her results showed that although e-cigarette vapors, in contrast to cigarette smoke, did not change the lung cells' DNA, they did initiate a stress response and were associated with a concentration-dependent decrease of cell viability. Moreover, these effects seemed to be induced by the carrier fluid of the e-liquid, whether or not it contained nicotine. Natalia believes this demonstrates a need for additional scrutiny of carrier fluids. She notes that future studies should also examine the effect of metabolites produced by cells during this stress response. Natalia attends **Garnet Valley High School** in Glen Mills. She is a competitive archer and an avid student of history and literature who frequently participates in writing workshops. Her parents are Dmitry and Yevgeniya Orlovsky.

2018 FINALISTS

Nitya Parthasarathy

Northwood High School
California

Nitya Parthasarathy, 17, of **Irvine**, developed an artificial intelligence (AI) tool to detect gender-biased language in social media for her Regeneron Science Talent Search **behavioral and social sciences** project. After tagging male- and female-linked words in online movie reviews, Nitya created an algorithm to detect such words, which served as the training model to detect potential gender-based stereotypes. She then tested the tool by predicting gender, based solely on surrounding text, with matches indicating the presence of bias. Finally, Nitya developed a probabilistic classifier metric to assign a "bias score" to the material. Nitya's resulting "BiasCheck" software demonstrates the effectiveness of using AI to study gendered text and extends to investigation of other forms of biased language. Nitya attends **Northwood High School** where she heads costume design for the school's drama theater and is co-director of the Junior Coding Club. She is also an award-winning performer of Indian classical cultural dance, rows with the Newport Aquatic Center and volunteers with children, elderly and homeless members of her community. She is the daughter of Rajalakshmi Kannan and Vasudevan Parthasarathy.

Mihir Vipul Patel

Thomas Jefferson High School for Science and Technology
Virginia

Mihir Vipul Patel, 17, of **Great Falls**, motivated by his aunt's struggle with lymphedema, created a smartphone-based program to measure limb volume for his Regeneron Science Talent Search **computer science** project. Currently, limb volume (swelling) is determined by measuring limb circumference at various points. To minimize error, which can be as high as 10 percent, these measurements must be taken carefully by clinicians, and therefore take time. Drawing on his experience with computer vision and telemedicine, Mihir created a system that measures limb volume from two smartphone pictures of the affected limb taken 90 degrees apart. When tested on model limbs, his application, which patients can use remotely, had only a 3.5 percent error rate. He hopes the next step will be clinical trials with lymphedema patients. Mihir is co-captain of the senior computer team and a member of the Future Problem Solving Club at **Thomas Jefferson High School for Science and Technology** in Alexandria. As co-founder and captain of the Machine Learning Club, he helps teach the theory behind machine and deep learning. The son of Vipul and Kirti Patel, Mihir is a defensive midfielder for a local soccer club.

Advait Patil

Lynbrook High School
California

Advait Patil, 17, of **San Jose**, developed a comprehensive framework to model cellular metabolism and interactions among cellular networks for his Regeneron Science Talent Search **genomics** project. Simple computational models lack practical utility because they typically incorporate only one aspect of a cell or its environment. Believing that scientists must understand cell systems in a complex, multicellular environment, Advait developed a comprehensive, integrated computational framework to describe all metabolic processes within a cell, predict interactions among cells and account for genetic control of cell responses to these interactions. Testing his model revealed new interactions among bacterial species and demonstrated its potential utility for representing acute myeloid leukemia. Advait co-founded Real Vegan Cheese, a biotechnology project, coaches middle school Science Bowl and Olympiad teams and volunteers with Grassroots Ecology and Action for a Healthy Planet. At **Lynbrook High School**, Advait is co-art editor of the *Vertigo* literary magazine. A 2014 gold medalist in the International Genetically Engineered Machine competition, Advait is the son of Shailaja and Avinash Patil.

Syamantak Payra

Clear Brook High School
Texas

Syamantak Payra, 16, of **Friendswood**, submitted an **engineering** project to the Regeneron Science Talent Search describing the electronically aided leg brace he developed to assist patients with lower limb impairment. Syamantak was motivated by the chronic back pain of his mentor, who walked with a conventional locked-knee brace due to post-polio syndrome. Syamantak's smart bionic brace bends the knee automatically based on the wearer's walking movements. In tests conducted on his mentor, the brace improved all eight of the measured walking gait characteristics; one gait parameter was restored to 99 percent of normal. Syamantak also wrote a smartwatch/smartphone app that allows the wearer to control the brace using voice commands. At **Clear Brook High School** he is a debater and the president of the National Honor Society and Chinese club. He is also a spelling bee coach for national-level spellers. The son of Pramatha Payra and Sanjukta Ghose, Syamantak received a 2016 Intel Foundation Young Scientist Award at ISEF for his early work on the brace, an honor that motivated him to pursue grant funding for a new STEM outreach program that reaches underserved students in grades three through five.

2018 FINALISTS

Dylan Pentland

The Newman School
Massachusetts

Dylan Pentland, 18, of **Boston**, used algebra to prove a new conjecture for his Regeneron Science Talent Search **mathematics** project. If you have *n* objects, how many possible ways are there to choose *k* of them, if the order in which you select objects does not matter? The answer to this question is expressed in 'binomial coefficients,' which are ubiquitous in mathematics as well as within physics, economics and biology. Binomial coefficients can be generalized as Gaussian polynomials, which, in turn, have applications in advanced mathematics and quantum physics. Although they are more powerful and sophisticated than binomial coefficients, Gaussian polynomials are also less well understood. Dylan helped enhance understanding of these complex polynomials by generating a proof of an MIT professor's conjecture about their structure. Dylan leads the math club at **The Newman School**, where he is also the founder and head of the computer science club and a head prefect. He volunteers as a math tutor and has worked as a teaching assistant for a computer science academy. Dylan, the son of Tracy Heibeck and Alex Pentland, received the American Mathematical Society's Ky and Yu-Fen Fan Scholarship in 2017.

Abilash Prabhakaran

Cherry Creek High School
Colorado

Abilash Prabhakaran, 17, of **Greenwood Village**, developed a potential new approach in delivering drugs to cancer cells for his Regeneron Science Talent Search **cellular and molecular biology** project. After witnessing his grandmother's cancer treatment, Abi pondered how drugs infused into an arm could reach a distant tumor in the breast. On learning that the membrane voltage of certain tumor cells differs from that of healthy cells, he wondered if this could be exploited for cancer therapy. The $DiBAC_4(3)$ molecule is known to have an affinity for cells at a membrane potential close to that of the cancer cells he examined. He observed that when bonded to nanoparticles, $DiBAC_4(3)$ seemed to increase particle delivery to breast cancer cells and inhibit delivery to non-cancer cells. His approach may help in reducing drug side effects and be the first time membrane voltage has been used for targeted cancer therapy purposes, in contrast with the methods typically used. The son of Preethi Mohandas, Abi attends **Cherry Creek High School**. He founded a summer tutoring program, raised money to buy computers for an underserved school district and organized a dance festival to raise money for a new Kriya Yoga temple.

Muhammad Shahir Rahman

Westview High School
Oregon

Muhammad Shahir Rahman, 17, of **Portland**, focused his Regeneron Science Talent Search **engineering** project on creating a microwave oven that safely and effectively warms food to desired temperatures while eliminating user input. Intrigued that cooking devices remain "dumb" in the age of "smart" technology, Shahir combined thermodynamics, electrical mechanisms and his own computational algorithms to model the effects of microwave radiation on food. Through multi-iterative systems engineering, he created controllers and programs to automatically detect a broad spectrum of foods, model their temperature characteristics and produce targeted heating to warm separate foods on the same plate to optimal temperatures – all tested in a used microwave oven he retrofitted for the study. His patent-pending, internet-enabled prototype may lead to safer, more effective microwave operation. Shahir runs competitive track and field and attends **Westview High School** where he is the president of the computer science club. Shahir helped create a smart bangle for use in poor countries that warns wearers of dangerous carbon monoxide levels. His parents are Rawshan Jahan and Asifur Rahman.

Michael Ren

Phillips Academy
Massachusetts

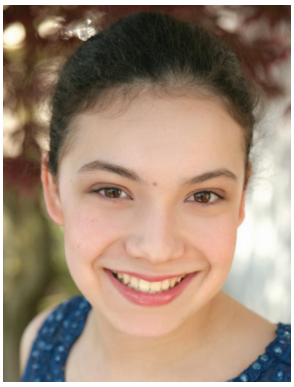
Michael Ren, 18, of **Andover**, used abstract algebra to study quasiinvariant polynomials for his Regeneron Science Talent Search **mathematics** project. Quasiinvariant polynomials are a generalization of symmetric polynomials (polynomials that remain the same when one variable is swapped for another). Using analysis and programming as well as algebra, Michael was able to calculate the Hilbert series of the space of quasiinvariant polynomials with two variables, and give new insights into series with more than two coefficients. Furthermore, he was able to do this in fields of positive characteristic, such as those related to prime numbers. This may help mathematicians develop a more rigorous and precise knowledge about these spaces by providing a sense of their size. Michael hopes that his work will prove useful in quantum physics and, one day, quantum computing. At **Phillips Academy**, Michael is a four-year member of the math club and tutors fellow students in math, chemistry and physics. He also coordinates a math-based community engagement program for students from underserved schools and is planning a mathematics competition for local middle school students. Michael is the son of Hui Qian and Baorui Ren.

2018 FINALISTS

Shuvom Sadhuka

Cambridge Rindge and Latin School
Massachusetts

Shuvom Sadhuka, 18, of **Cambridge**, explored the properties of recently discovered materials, called topological insulators (TIs), that act as insulators internally but as conductors on their surface for his Regeneron Science Talent Search **physics** project. TIs may have applications in quantum computing, magnetics and optics because practical TIs could permit the creation of structures smaller than those achievable with current transistor technology. To more intuitively understand the properties of TIs, Shuvom sought to explore how the parameters of a lattice metamaterial, such as density or properties affecting wave transmission, affect their ability to act as TIs. He developed algorithms and used 3D-modeling software to simulate the behavior of electrons on the lattice metamaterial and concluded that only three parameters are needed to identify whether a given lattice can act as a TI. He also identified how those parameters establish the shape of the lattice. Shuvom attends **Cambridge Rindge and Latin School** where he is an active member of the math club and is a skipper on the varsity sailing team. He enjoys studying Latin and has won multiple awards in chemistry, math and debate. His parents are Jayati and Ramkrishna Sadhukhan.



Raley Schweinfurth

Oregon Episcopal School
Oregon

Raley Schweinfurth, 18, of **Portland**, investigated how insecticides can contaminate honey and affect bee foraging sites for her Regeneron Science Talent Search project in **environmental science**. Following a 2013 insecticide spraying incident in Oregon that killed more than 50,000 bees, Raley began a three-year investigation of contamination levels by analyzing honey produced before and after a state ban on insecticides, as well as tree and soil samples from the affected regions. Using chromatography techniques to detect contamination levels, she determined that the insecticide in honey and soil lingered for several years after a single spraying event. Her research also indicated that cultivating native greenery and bacteria at contaminated sites may help remove accumulated insecticide. The daughter of Leyan Fernandes-Schweinfurth and Ralph Schweinfurth, Raley attends **Oregon Episcopal School**. She founded a Latino/Hispanic affinity group to promote multicultural diversity and inclusion and also captains an Ultimate Frisbee team. Raley is principal keyboardist with the Portland Youth Philharmonic (playing piano, celesta and harpsichord) and volunteers for a local non-profit that promotes music education.

Haniya Shareef

Lincoln Park Academy
Florida

Haniya Shareef, 17, of **Port St. Lucie**, identified a method to potentially control the spread of one of the world's most invasive weeds, purple nutsedge, for her Regeneron Science Talent Search **plant sciences** project. Rust fungi, which are obligate parasites, are used as biological control agents to control several invasive weeds, but are ineffective against purple nutsedge, which has spread to 92 countries and negatively impacts crop yields. Haniya studied the morphological and genetic characteristics of rust fungi infecting purple and yellow nutsedge and identified a rust discovered on purple nutsedge for the first time. Haniya also improved the germination rate of the fungus using plant-based volatiles, such as coumarin, which may increase its effectiveness as a bioherbicide for invasive species without risk to non-targeted plants. At **Lincoln Park Academy** in Fort Pierce, she played varsity tennis, and performs euphonium and classical piano. The daughter of Naheed and Humayun Shareef, Haniya has studied invasive species since the sixth grade. She also founded and coordinates "We Got the Keys," an organization promoting self-esteem and positive thinking in teens from dysfunctional families.

Isani Singh

Cherry Creek High School
Colorado

Isani Singh, 18, of **Aurora**, focused her Regeneron Science Talent Search **genomics** project on a deeper understanding of Turner Syndrome (TS), a genetic abnormality in which the second sex chromosome is missing. Because most embryos lacking the second X do not survive, Isani hypothesized that two copies of certain sex chromosome genes are essential to viability, implying that people with TS must have some cells with two sex chromosomes. She adapted a relatively new laboratory protocol to search for and find sex chromosomes in TS embryos. She also identified specific genes that are under-expressed in TS, a finding that may hold promise for gene therapy or protein replacement treatments. Motivated by her own fascination with rare medical conditions, Isani hopes her work will help physicians and patients alike better prepare for the variable medical complications of TS. She has raised $2,400 to help patients attend the National Turner Syndrome Conference. At **Cherry Creek High School** in Greenwood Village, Isani leads the Policy Debate and Science Bowl teams and a nationally recognized math club. She founded the Denver Math Club to inspire female mathematicians. Isani's parents are Benu and Shailendra Singh.

2018 FINALISTS

Marissa Sumathipala

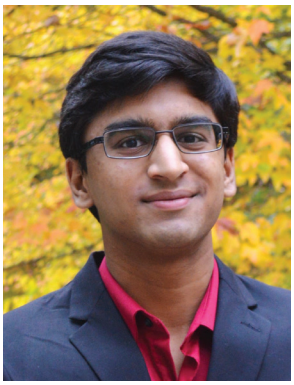
Broad Run High School
Virginia

Marissa Sumathipala, 17, of **Ashburn**, investigated cardiovascular disease (CVD) by studying the hearts of fruit flies for her Regeneron Science Talent Search **cellular and molecular biology** project. Her dual therapeutic strategy, comprised of two proteins, targeted the underlying molecular causes of CVD, requiring her to perform fruit fly heart surgery and tissue imaging analysis to assess the therapeutic's efficacy. She found that one protein, FOXO, dramatically reduced cardiac dysfunction and hypertrophic heart failure, and the other, AMPK, reduced glycemic (sugar) levels. Additionally, FOXO and AMPK resulted in an increase in fruit fly survival from 50 to 100 percent. At **Broad Run High School**, Marissa leads ONEVoice, a student advocacy network organized to end extreme poverty. The daughter of Nina Arendtsz and Kuma Sumathipala, Marissa is a top competitive figure skater and ice dancer, and coaches for the Special Olympics. She also is founder and captain of her county's first genetic engineering team, which raised $22,500 from corporate sponsors to genetically engineer yeast to treat wastewater, and test its efficacy by building a prototype of an industrial wastewater treatment plant.

Grace Tian

The Wellington School
Ohio

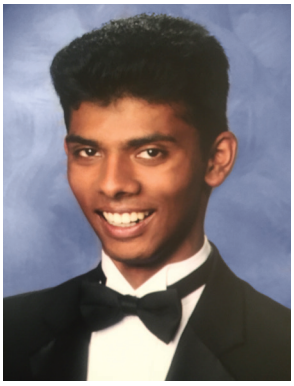
Grace Mingrong Tian, 17, of **Hilliard**, unraveled a knot theory problem for her Regeneron Science Talent Search **mathematics** project. Here is an example of a knot theory problem: If you have two shoelaces, each containing a different knot, and tie together the free ends of each lace, can you then replicate the knot found in one shoelace in the other shoelace without untying the ends? In her study, Grace worked with idealized mathematical ribbons rather than shoelaces, which adds the variable of width. She used grid diagrams to provide an upper bound, or worst-case scenario estimate, on the minimal ratio of the length to width of a knotted ribbon in terms of how many times the ribbon crosses over itself. Not only was she able to prove a very general theorem about all such knots, but she also was able to give an even better bound for many important special cases. Knot theory is a mathematical field that has direct applications to biology and the replication of knotted DNA. The daughter of Fei-Ran Tian and Shanghong Dong, Grace attends **The Wellington School** in Columbus where she co-leads the math club, enjoys ceramics and played junior varsity tennis. She also volunteers at the Center of Science and Industry in Columbus.



Vinjai Vale

Phillips Exeter Academy
New Hampshire

Vinjai Vale, 17, of **Exeter**, worked on improving the abilities of neural network-based image analysis programs for his Regeneron Science Talent Search **computer science** project. Although many effective techniques exist for classification of objects in an image, even the most sophisticated technology has difficulty with representation of objects. For example, a state-of-the-art convolutional neural network (CNN) may mistakenly identify a leopard print sofa as an actual leopard, because of overemphasis on texture and an inability to represent spatial structure. Designers of self-driving vehicles face a similar challenge. Vinjai developed a domain, data set and software that have the potential to greatly improve the ability of CNNs to handle representational tasks. Vinjai, the son of Sara and Rajesh Vale, competes on the Olympiad math team at **Phillips Exeter Academy**, where he founded Puzzle Hunt, a weekend competition in which teams race to solve a series of creative puzzles leading to a hidden object. The two hunts Vinjai organized each drew about 250 students and faculty, and he hopes the event will become an annual school tradition. He also co-founded a full-day hackathon for New England high school students.

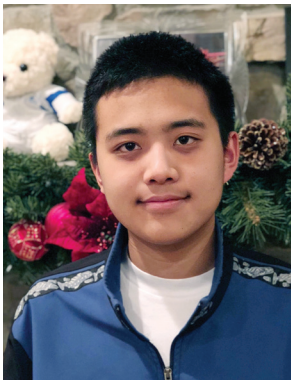


Teja Sai Veeramacheneni

Archbishop Mitty High School
California

Teja Sai Veeramacheneni, 17, of **Fremont**, submitted a **computer science** project to the Regeneron Science Talent Search with the goal of improving investigations into Alzheimer's disease. Teja developed an algorithm, RWT3Coreg, to align and simultaneously view the two kinds of brain scans, functional (PET) and structural (MRI) images, that are used to investigate Alzheimer's and other neurodegenerative diseases. RWT3Coreg outperformed almost all of the algorithms that are currently used to do this, suggesting that it may help researchers who are studying neurodegenerative diseases. Teja also created prototype software that can simultaneously display PET and MRI brain scans in real time 3D, which allows for more versatility in visualization than standard techniques. At **Archbishop Mitty High School** in San Jose, Teja is a leader of the state championship speech and debate team, officer of the astronomy club and organizer of a 2018 Hackathon. During the past two summers, Teja worked at Brain Health Alliance, a non-profit organization that helps create software applications to combat neurodegenerative diseases. His parents are Sailaja Ravi and Ramu Veeramacheneni.

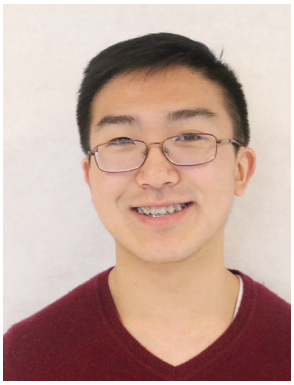
2018 FINALISTS



Franklyn Hai Wang

Thomas Jefferson High School for Science and Technology
Virginia

Franklyn Hai Wang, 17, of **Falls Church**, solved an important 100-year-old math problem for his Regeneron Science Talent Search **mathematics** project. A rational function is a ratio between two polynomials, where a polynomial is an expression of algebraic terms, such as 3x^2-2x. Even though rational functions are so closely related to polynomials, they are far less understood. In his work, Franklyn was able to bring a new insight to rational functions by providing a new way of classifying nearly all rational functions. He was able to solve this fundamental problem by combining methods from the fields of algebraic geometry, Galois theory, group theory, representation theory and combinatorics. His work could prove significant in many areas of mathematics and may also have various engineering and science applications. Franklyn, the son of Ge Wang and Weiwen Chen, attends **Thomas Jefferson High School for Science and Technology** in Alexandria. He co-captains the physics team, leads the Science Bowl team and competes on both the math and computer teams. His participation has helped propel all four clubs to earn top awards in numerous national competitions.



David Xing Wu

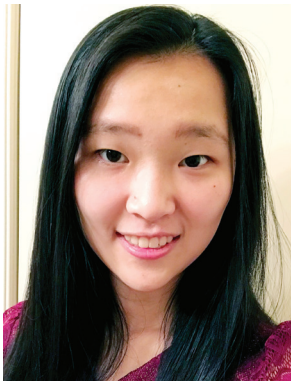
Montgomery Blair High School
Maryland

David Xing Wu, 17, of **Potomac**, worked in the area of prime numbers and, more specifically, the patterns of sequential prime numbers for his Regeneron Science Talent Search **mathematics** project. Irregularities in these patterns often lead to new conjectures, but collecting data on these irregularities and connecting them to existing theory can be difficult. David first improved the current methods for gathering data on prime number patterns by several orders of magnitude, which could have an impact on cryptography and cybersecurity. Then, using the additional data, he was able to propose a possible lower bound on formulas for predicting these irregularities via curve fitting. Next, David was able to start rigorously connecting conjectures about these patterns with more standard number theory work. This has the potential to make future work on prime number patterns much more productive. At **Montgomery Blair High School** in Silver Spring, David is a member of the physics team and captain of the math and Science Bowl teams. David, the son of Meiyu Shen and Huiquan Wu, has attended Chinese school since he was five years old, and he has played the cello for several of the Maryland Classic Youth Orchestras since seventh grade.

Justin Long Xie

The Harker School
California

Justin Long Xie, 17, of **Cupertino**, submitted a **space science** project to the Regeneron Science Talent Search that investigated the probable mechanisms of Type Ia supernovae. Justin focused on analyzing the spectral composition of stars in dwarf galaxies – specifically iron-peak elements, such as chromium, cobalt and nickel, which provide clues about how the stars were formed and their material properties. He analyzed the elemental composition of stars in eight different galaxies, extracting information about supernovae from the past, and compared his findings against four prevailing theoretical supernova models. His findings support the idea that a Type Ia supernova results from a process in which the star's burning core yields thermonuclear runaway. Justin is a student at **The Harker School** in San Jose where he competes on the debate team and serves as a team captain. An avid boy scout and award-winning vocalist, he is the son of Xiaozhong Yao and Bo Xie. Justin is also particularly active as a community advocate and has participated in a U.S. congressman's Student Advisory Council to promote legislative change, including co-authoring a policy proposal to reduce human trafficking in corporate supply chains.



Alice Anran Zhang

Montgomery Blair High School
Maryland

Alice Anran Zhang, 17, of **Potomac**, created a traffic signal protocol to speed the flow of cars and trucks driving through intersections for her Regeneron Science Talent Search **computer science** project. Her traffic control system requires two-way wireless communications among approaching vehicles as well as software that manages the stop lights at the intersection. The system relies on her protocol to plot the position, speed and intended path of each approaching vehicle and then allows it to proceed through the intersection only if it can do so safely, avoiding all other vehicles. The protocol slows or stops an approaching vehicle if there is a danger of a crash, and it gives priority to any vehicle that has waited overlong. Her computational approach integrates concepts from mathematics and game theory. At **Montgomery Blair High School** in Silver Spring, Alice is a director of the math honor society and peer tutor. During a summer internship at the NIH, she built algorithms to create a massive database of certain blood cells and then created a web application so biologists there could easily access and visualize data sets. A singer and pianist, Alice is the daughter of Wei Ding and Zhijun Zhang.

REGENERON SCIENCE TALENT SEARCH 2018 | Finalists by State

REGENERON SCIENCE TALENT SEARCH 2018 | 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 education competitions, including the Regeneron Science Talent Search, the Intel International Science and Engineering Fair and the Broadcom MASTERS, and the Science News Media Group, including the award-winning *Science News* and *Science News for Students*, the Society is committed to inform, educate and inspire.

Learn more at:
www.societyforscience.org.
https://www.facebook.com/societyforscience
https://twitter.com/Society4Science
https://www.instagram.com/society4science/
https://medium.com/@society4science
Snapchat: Society4Science

REGENERON
SCIENCE
TALENT SEARCH
A program of
SOCIETY FOR SCIENCE
& THE PUBLIC
Since 1942

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 six FDA-approved medicines and numerous product candidates, all of which were homegrown in our laboratories. Our medicines and pipeline are designed to help in a range of diseases, including eye disease, allergic and inflammatory diseases, cancer, pain, 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 efforts. We support many local and national initiatives, with a focus on supporting top student talent, diversifying the talent pool and increasing access to STEM education for underrepresented populations.

Learn more about our programs at:
www.regeneron.com/scienceeducation
https://www.facebook.com/Regeneron
https://twitter.com/regeneron

Society for Science & the Public
1719 N Street, NW
Washington, DC 20036-2801
202.785.2255 telephone
202.785.1243 fax
student.societyforscience.org/regeneron-sts