REGENERON

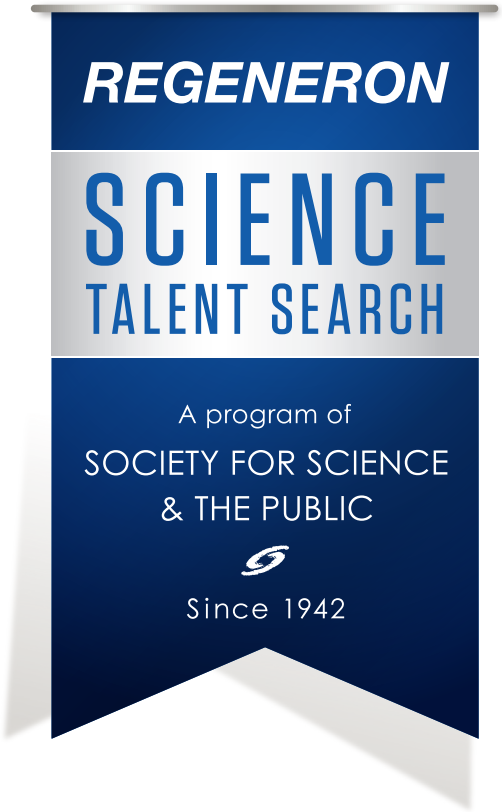
SCIENCE TALENT SEARCH

A program of
SOCIETY FOR SCIENCE & THE PUBLIC

Since 1942

REGENERON SCIENCE TALENT SEARCH

2020 FINALISTS



2020 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 2020

MARCH 5–11, 2020

The 40 finalists of the Regeneron Science Talent Search 2020, 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 36 schools and one home school in 21 states. Finalists were selected from almost 2,000 entrants, representing more than 659 high schools in 49 states, Washington, D.C., Puerto Rico, Guam and eight 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 2020 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.

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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 2020 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 23,871 finalists and scholars who have received $26.8 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. A team of scientific evaluators and judges review applications and select 300 scholars and 40 finalists from the entrant pool.

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 Showroom, 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 10.

Each of the 300 students named a scholar in the Regeneron STS 2020 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 2020. The award is used to advance excellence in science, math and/or engineering education at the recipient school.

2020 FINALISTS

Jagdeep Bhatia

Watchung Hills Regional High School
New Jersey

Jagdeep Bhatia, 17, of **Green Brook**, developed new machine learning algorithms that could be used to train robots for his Regeneron Science Talent Search **computer science** project. Jagdeep's project is in the field of interactive machine learning, where a computer program tries to learn a concept under the tutelage of an instructor (a human or another computer). These types of programs make guesses at the concept to be learned, with the instructor correcting any errors. Jagdeep developed two algorithms that describe which concepts should be guessed so as to learn the concepts as quickly as possible. His algorithms not only ask random questions but, like a savvy detective, ask just the right ones. Jagdeep's findings also suggest that his algorithms learn at a nearly optimal rate, asking no more questions than necessary. Jagdeep is a varsity cross country runner at **Watchung Hills Regional High School** in Warren, and a team leader of his regional robotics club. As founder of HillsX, a club for students who want to start businesses, Jagdeep connects local professionals with teams of students attempting to create new products. The son of Randeep and Irvinder Bhatia, Jagdeep also coaches a middle school MathCounts team.

Amogh Bhatnagar

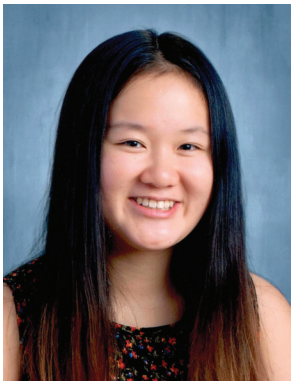
University School of Milwaukee
Wisconsin

Amogh Bhatnagar, 18, of **Mequon**, developed a methodology to compare the cost effectiveness of laparoscopic appendectomy (LA) to open appendectomy (OA) surgery performed nationwide in children for his Regeneron Science Talent Search **computational biology and bioinformatics** project. He believes this method could be used to compare the costs of any set of options for a given surgery. LA is performed through Band-Aid sized incisions using microsurgical tools and is generally preferred over traditional open surgery because of reduced infection risk, faster recovery time and shorter length of stay. Amogh examined the Kids' Inpatient Database and found that length of stay for LA was only a half day shorter than OA, yet costs roughly $3,600 more. Amogh questions if this modest stay reduction can be justified, noting that if all appendectomies were open, the annual savings would exceed $1.2 billion. The son of Amit Bhatnagar and Samta Pradhan, Amogh attends the **University School of Milwaukee**. He is one of the founders of the Wisconsin Student Research Society, an organization that helps high school researchers conduct their projects. Amogh is also a pianist who has received 10 consecutive Milwaukee Area Piano Teachers Association awards.

Andrew John Brinton

John F. Kennedy High School
New York

Andrew John Brinton, 17, of **Merrick**, studied the role that ribbed mussels play in preserving salt marshes for his Regeneron Science Talent Search **environmental science** project. Andrew was inspired to find ways to offset the effects of climate change after a storm surge caused by Hurricane Sandy destroyed part of his home when he was 10 years old. After learning that the loss of coastal wetlands on Long Island exacerbated such events, Andrew studied 10 coastal marsh sites and established that healthy marshes -- the kind that act as natural barriers to storm surges -- contain both ribbed mussels and Spartina (salt water cordgrass) in a synergistic relationship. By comparing old and recent maps, he also deduced that Long Island's marshlands are being lost at 6.5 to 20 times the national rate. He suggests that coastal marshes be seeded with ribbed mussels and that no-wake zones be better enforced in such areas. Andrew competes in the Science Olympiad and is president of the Mock Trial Club at **John F. Kennedy High School** in Bellmore. The son of Scott and Katerina Brinton, Andrew is also an accomplished musician, having received awards for his solo performances on the tenor saxophone.

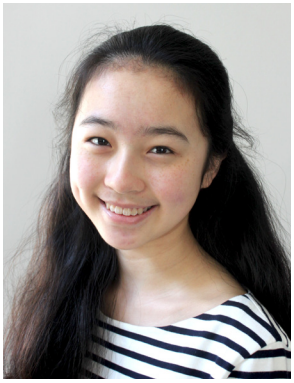


Cynthia Chen

The Harker School
California

Cynthia Chen, 17, of **Cupertino**, built a computational pipeline, or series of computing instructions, that can decode hidden patterns in an AI model trained on a pan-cancer data set and extract key signatures of different cancer types for her Regeneron Science Talent Search **computational biology and bioinformatics** project. She believes her new pipeline model could help improve treatment for cancer patients and lead to wider acceptance of AI. Cynthia's pipeline consists of several stages: generating random input sequences, running the model to rank them, clustering top sequences to characterize motifs (sequence patterns) and visualizing motif clusters with unique identifiers. Using her pipeline, she discovered and validated 65 anti-tumor motif signatures of 13 common cancer types. Cynthia is a Mathlete who has represented **The Harker School** in San Jose at several national math competitions. She is president of both the Research and Artificial Intelligence Clubs and founder and CEO of Opportunity X, a national organization that brings research opportunities to underrepresented students. She loves volleyball and plays on multiple teams. Her parents are Jin Cheng and Dong Chen.

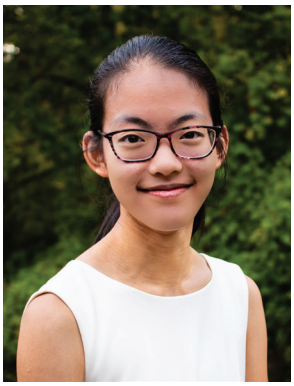
2020 FINALISTS



Lauren Yuqing Chen

Dutch Fork High School
South Carolina

Lauren Yuqing Chen, 16, of **Irmo**, focused her Regeneron Science Talent Search **medicine and health** project on the role of microRNA molecules in predicting, and possibly promoting, breast cancer recurrence. Lauren used a real-time quantitative technique to analyze serum samples from both recurrent and non-recurrent breast cancer patients for differentially expressed microRNA, and statistically correlated them with other clinical factors. She found that the serum level of a microRNA called miR-134 could predict tumor recurrence. Although the overexpression of this biomarker did not affect tumor proliferation, it did alter cell communication, changing the functionality of certain immune cells from anti-tumor to tumor promoting. Her work may point to circulating miR-134 as a new biomarker to help predict breast cancer recurrence and progression. At **Dutch Fork High School**, Lauren is founder and president of a mathematics honor society and president of Future Business Leaders of America. She also plays violin and piano, is CEO of a student-run fundraising business and lead author of an article published in the journal *Clinics in Oncology*. Her parents are Chongyan Huo and Hexin Chen.



Holly Cheng

Horace Greeley High School
New York

Holly Cheng, 18, of **Mount Kisco**, applied her Regeneron Science Talent Search **cellular and molecular biology** project to finding new molecular target regions for CRISPR Cas9 gene editing in the treatment of sickle cell disease. Reactivating fetal hemoglobin, which is typically turned off after birth in sickle cell patients, may be key to restoring the function of red blood cells. Holly isolated red blood cell precursors from bone marrow, which she had determined to be most efficient for editing DNA. She then used CRISPR Cas9 to delete portions of DNA implicated in decreased production of fetal hemoglobin. After confirming the deletions through DNA sequencing, Holly found increased expression of fetal hemoglobin in the red blood cell precursors. Her work may lead to future gene therapy for sickle cell disease. A student at **Horace Greeley High School** in Chappaqua, Holly is captain of the cross country team and earned a letter in varsity track and field. She also plays violin and is the 2018 winner of the Long Island Conservatory Soloist Competition for piano. The daughter of Yi Fan and Haiping Cheng, Holly volunteers as a teaching assistant at Huaxia New York Central Chinese School.

Brendan Crotty

Hickory Hill Academy Homeschool
Oklahoma

Brendan Joseph Crotty, 17, of **Muskogee**, designed and built a prototype of an industrial gas burner with lower emissions of NOx (nitrogen oxide gases) and improved heat transfer for his Regeneron Science Talent Search **engineering** project. Environmental pollutants, NOx are byproducts of burning hydrocarbon fuels such as natural gas. After studying several commercial burners, Brendan designed a hybrid burner with a specialized nozzle and gas diffuser that he believed would reduce NOx. To build his model, he had to become proficient in design software, metal casting and machining methods. His most recent prototype, the result of three years of design revisions, reduces NOx emissions by 19 percent and operates at higher temperatures and greater thermal efficiency than conventional burners. Brendan believes his work could help industries like cement manufacturing to reduce its environmental impact. The son of Jennifer and James Crotty, Brendan attends **Hickory Hill Academy Home School**. He is the only student committee member of Dream It Do It Oklahoma, which promotes manufacturing statewide. A skilled blacksmith, he demonstrates 1850s techniques at Hunter's Home, an Oklahoma Historical Society site.

Ankush K. Dhawan

Signature School
Indiana

Ankush Kundan Dhawan, 18, of **Newburgh**, developed a less expensive method to detect trace levels of arsenic in water for his Regeneron Science Talent Search **environmental science** project. Arsenic is naturally present at hazardous concentrations in much of the world's groundwater. Recognizing its adverse effects on human health, the U.S. EPA reduced the arsenic drinking water standard in 2006 from 50 ppb to 10 ppb. However, accurately measuring arsenic below 20 ppb requires water supply companies to use costly analytical techniques. By refining a previously developed method, Ankush was able to reduce the detection limit to 3.5 ppb. Then, to detect arsenic in remote areas, he developed a fast and portable visual test that, once commercialized, could be used to detect arsenic concentrations of about 50 ppb for less than one tenth the cost of existing methods. Ankush is president of the robotics and chess clubs at the **Signature School** in Evansville. The son of Sandeep and Radhika Dhawan, Ankush also serves as a volunteer member of Vanderburgh County's Teen Court system. He has published a manuscript in *Heliyon*.

2020 FINALISTS

Maria Liberty Fields

University-Liggett School
Michigan

Maria Liberty Fields, 17, of **Detroit**, used her Regeneron Science Talent Search **computational biology and bioinformatics** project to investigate a possible genetic basis for the fact that African American (AA) women are more likely to be diagnosed with triple-negative breast cancer (TNBC) and suffer a higher mortality rate than European American (EA) patients with TNBC. To explore the disparity, which recent studies suggest may not be explained solely by socioeconomic factors, Maria applied modern computational and statistical analysis methods to gene expression data from tumors of patients classified by race and found significant differences in gene expression. Through direct comparison of AA and EA tumor tissue she then identified these differences in specific genes that control the machinery of cell division. Maria's findings may point to a causal role for gene expression in the disparity in outcomes for AA women with TNBC. Maria attends **University Liggett School** in Grosse Pointe Woods, where she runs varsity track and field and performs with The Liggett Players thespian troupe. The daughter of Malita and Alfred Fields, Maria also is a reading mentor with Soar Detroit.

Ari Joseph Firester

Hunter College High School
New York

Ari Joseph Firester, 17, of **New York City**, focused his **engineering** project for the Regeneron Science Talent Search on building earthworm-inspired robots, using methods and materials he fashioned at home. Moved by the news of the Thai soccer players trapped in a cave, Ari turned to biomimicry to create worm-like robots that could maneuver through spaces not much wider than their own bodies by elongating and contracting. His first simple yet rugged design used pneumatic actuation through a series of linked compressed-air tubes. His second design used electronic servo motors and an onboard microcontroller to permit greater freedom of movement. Specifically, this robot's segments move as independent "worms" or, alternatively, connect head-to-tail with other segments so they can work as a single multi-segment robot during disaster relief tasks. At **Hunter College High School**, Ari is co-concertmaster of the Senior Strings and violinist in the chamber music ensemble. He has played the violin for 13 years. He is also a klezmer fiddler, writes klezmer folk tunes and studies Yiddish. The son of Ruth and Jonathan Firester, Ari describes himself as a "garage and kitchen scientist."

Makayla Gates

Valencia High School
New Mexico

Makayla R. Gates, 18, of **Peralta**, used her Regeneron Science Talent Search **plant sciences** project to determine if feeding socially unresponsive honeybees with a botanical form of lovastatin could serve as a human model for relieving social anxieties associated with fragile X syndrome (FXS), the most frequent cause of autism spectrum disorder. Using hives owned by her grandparents, Makayla identified unsocial bees by quantifying their interactions with and proximity to others. She then prepared and fed test subjects one of three different botanical solutions containing lovastatin and retested their interactions in a sociability chamber she built herself. Results showed a significant increase in social behavior among botanically fed bees, with the mushroom diet producing the greatest improvement, as compared to no change among bees fed only sugar syrup. Makayla's work may highlight a therapeutic role for natural supplements in treating FXS. In addition to attending **Valencia High School** in Los Lunas, Makayla performs classical music on folk harp and volunteers as a nature guide in the ABQ BioPark and a docent at the New Mexico Museum of Natural History and Science. Her parents are Holly Ice-Gates and Merle Gates.

Victoria Graf

Thomas Jefferson High School for Science and Technology
Virginia

Victoria Graf, 17, of **Arlington**, investigated the effect of familiarity and musical training on the interaction between the complexities of music and neurological response for her Regeneron Science Talent Search **behavioral and social sciences** project. Using electroencephalography (EEG), music stimuli and participant data from a Stanford University study, Victoria measured EEG responses to music and how they were affected by the participants' musical background. She found that a musical stimulus, when tailored to a listener's musical experience, could stimulate higher-level brain activity. She believes her research could lead to low-cost treatment for disorders associated with low-complexity brain activity, such as Alzheimer's disease. Victoria attends **Thomas Jefferson High School for Science and Technology** in Alexandria. Among many activities, she is president of the school Neuroscience Society and was the orbit-modeling programmer for a student team that sent a satellite into space. The daughter of Louise and Spencer Graf, Victoria has a black belt in Karate and is an accomplished pianist who has performed at elite recital halls in London, New York City and Washington, D.C.

2020 FINALISTS

Zander Hill

BASIS Scottsdale
Arizona

Zander Douglas Hill, 18, of **Scottsdale**, significantly extended previous work on the distortion of torus knots for his Regeneron Science Talent Search **mathematics** project. The torus knots are formed by winding a string in various ways around an invisible bagel, whose shape is called a torus, before tying the ends of the string together. After someone winds and ties the string, points along the string may be much closer to each other than they were when the string is straightened out. The largest ratio of those two distances between any two points on the string is a measurement of the knot's distortion. Zander extended previous work and showed that for torus knots winding far more around the inner loop of the torus than the outer loop, the distortion increases slowly with respect to the number of windings around the inner loop. Zander's results help expand mathematicians' knowledge of knots and may help make this notoriously difficult field less so. Zander attends school at **BASIS Scottsdale** where he is the founder and president of the math society and writes and creates puzzles for the *BASIS Gazette*. The son of Laura Weinrich and Leonard Hill, Zander hopes to make mathematics research and teaching a lifelong career.

Raina Jain

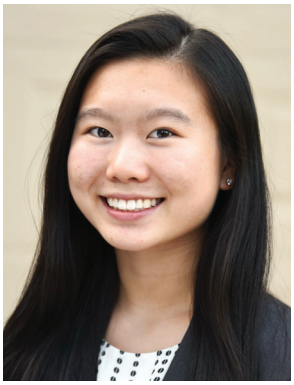
Greenwich High School
Connecticut

Raina Jain, 17, of **Riverside**, created a dual-function, toxin-emitting entranceway (DF-TE) to protect bees from Varroa mites, a leading cause of colony collapse, for her Regeneron Science Talent Search **animal sciences** project. To create the entranceway, Raina 3-D printed a rectangular block with holes in it and coated it with a time-release gel she made using thymol, a Varroa toxin. Raina calculated how much thymol a foraging bee collects while passing through one of the entrance holes and then used a gel-coated drone propeller for simulation to determine how much the gel degrades in flight. She found that it takes four days for a bee to collect the 56 micrograms of thymol required to kill the parasite. The DF-TE also outgasses into the hive to protect bees that never leave, without contaminating honey or eggs. Her patented DF-TE is being tested on hives around the country. The daughter of Rashmi and Vijay Jain, Raina attends **Greenwich High School**. A committed volunteer and entrepreneur, Raina is developing two businesses, mentors elementary students, teaches English to immigrants, works with the New England Water Environment Association, and has helped build a playground for disadvantaged children in India.

Anushka Sameer Jetly

Friendswood High School
Texas

Anushka Sameer Jetly, 17, of **Friendswood**, created two affordable smartphone-based diagnostic tools to detect middle ear abnormalities caused by infections that may lead to hearing loss for her Regeneron Science Talent Search **bioengineering** project. During a trip to Mumbai, India, Anushka was surprised to see many children with hearing impairments, conditions that may have been prevented with early diagnosis and intervention. Anushka invented two portable diagnostic devices for use in rural, low-income areas of the world. Her smart otoscope can automatically detect ear drum infections and her smart tympanometer can categorize different types of middle ear infections. She believes both could be used to address a significant number of childhood hearing disorders, noting that together her tools cost under $200 as compared to about $4,800 for conventional devices. At **Friendswood High School**, Anushka is a four-year member of the Latin Club and a member of Academic Decathlon. The daughter of Monika and Sameer Jetly, Anushka holds a black belt in Taekwondo and is founder of a charity that has made large grants to a school for hearing impaired children in India as well as a local home for adults with disabilities.



Helena Jiang

Buchholz High School
Florida

Helena Jiang, 17, of **Gainesville**, sought an easy and inexpensive way to identify environmental pollutants, so, for her Regeneron Science Talent Search **chemistry** project, she invented color-changing polymer sensors that can detect toxins in air, water and plastics. Inspired by cheap yet effective pH paper that's commonly used to quantify acidity in liquids, Helena developed a colorless strip that can easily and affordably detect and signal even trace amounts of certain pollutants in the environment by changing colors. She combined the concepts of bioinspired structural colors with a smart material called a shape memory polymer. In addition to easy-to-see color changes, Helena created a convenient smartphone-based mobile platform to quantify the pollutants. She expects her patent-pending sensors could be used to reveal toxic gases, such as formaldehyde, and help law enforcement detect explosives. At **Buchholz High School**, Helena's passions include tennis and the speech and debate club. She is especially proud of inspiring more girls to learn programming through coderGirls. The daughter of Peng Jiang and Julie Wang, she is founder and CEO of a nonprofit organization that seeks to "spread the art of nanoscience."

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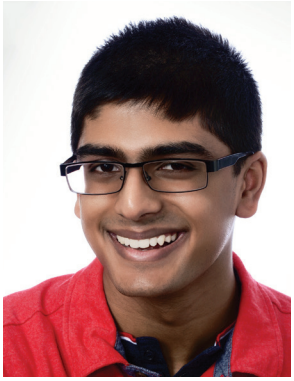


Nithin Kavi

Acton-Boxborough Regional High School
Massachusetts

Nithin Kavi, 18, of **Acton**, showed the equivalence of some very complex constructions for his Regeneron Science Talent Search **mathematics** project. Suppose someone had a wheel with sections that were alternatingly colored white and black, and long flexible ribbons, each with one long white edge and one long black edge. If you connect the ends of the ribbons to the white and black boundaries of the wheel so that the white edges of a ribbon touch the white sections of the wheel and vice-versa, then the entire construction is called "balanced" if the number of white and black boundary components occur in equal number. Nithin showed that any balanced wheel and ribbon arrangement could be turned into any other balanced arrangement by repeatedly using specific cutting and gluing operations. Nithin is the son of Madhuri and Prabhu Kavi and attends **Acton-Boxborough Regional High School**, where he has served as the Class Leader since freshman year. Nithin competes through the U.S. Chess Federation and has twice achieved national first place awards, recently earning the rank of Original Life Master. Additionally, he is certified as a chess tournament director and has published two articles in chess magazines.

Olivia Rose Krivitsky

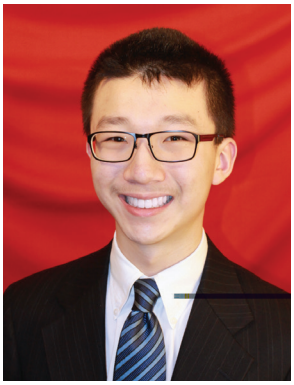
Bergen County Academies
New Jersey

Olivia Rose Krivitsky, 17, of **Englewood Cliffs**, studied the potential for ketone bodies — compounds with anti-inflammatory properties produced when fats are broken down — to treat diabetic eye diseases, such as retinopathy and macular degeneration, for her Regeneron Science Talent Search **cellular and molecular biology** project. Diabetic eye diseases are linked to reactive oxygen species (ROS) – unstable oxygen molecules — induced by high glucose levels. Some diabetics have reported that a high-fat, low-carbohydrate keto diet improved their symptoms. This led Olivia to question whether diabetic eye diseases would respond to treatment with supplemental ketone bodies. To find out, she treated a model of a diabetic retina with the ketone body 3-Hydroxybutyrate and observed that it reduced ROS and other adverse effects. The daughter of Viola and Valentin Krivitsky, Olivia attends **Bergen County Academies** in Hackensack. As an executive member of Diversity Alliance, she is committed to fostering gender diversity in research. She also volunteers as a STEM tutor and interns in the neurosurgery department of a local hospital and with a pharmaceutical company. Olivia loves ballroom dancing and has won numerous competitions.

Caitlin Rita Kunchur

Dutch Fork High School
South Carolina

Caitlin Rita Kunchur, 17, of **Irmo**, submitted a **physics** project to the Regeneron Science Talent Search that examined the effect of a room's acoustic properties on speech intelligibility and sound. Using free software and two laptops with built-in microphones and speakers, Caitlin measured reverberation decay time, reverberant intensity and overall sound absorption in three different rooms: a bathroom, foyer and bedroom. She then conducted 261 blind tests to test how well participants could distinguish the spoken sounds "ch" and "j" in the three rooms. Her findings supported previous studies on reverberation time, and further showed that more reverberation at the speaker's location, coupled with additional absorption near the listener, are best for distinguishing speech. Caitlin, who had hearing difficulties at a young age, hopes her work informs acoustic designs for small areas like classrooms where speech intelligibility is paramount. Her work has been published in two peer reviewed journals. The daughter of Milind Kunchur and Varsha Kulkarni, Caitlin attends **Dutch Fork High School** where she captains the Science Olympiad, is editor and writer of the *STEM Observer* newspaper and plays violin in the orchestra.



Rupert Michael Li

Jesuit High School
Oregon

Rupert Michael Li, 17, of **Portland**, investigated the algebra of the abelian sandpile model for his Regeneron Science Talent Search **mathematics** project. Although this model has various applications that have nothing to do with sand, it is commonly thought of as a "sandbox" in which grains of sand are added until gravity causes steep piles to collapse and rearrange. Rupert studied the abstract algebra of these sandpiles, focusing on "identity piles." Just as adding zero and a number leaves that number unchanged, there are identity piles, which when added to any sandpile, leave it unchanged. Rupert addressed models in which the identity piles are equivalent to the maximum stable configuration. This means, to use the sandbox analogy, a configuration with so much sand everywhere that adding a single grain to it anywhere would cause the whole pile to collapse. He answered this question for models depicted on graphs that represent, for example, sand with differing coefficients of friction and underlying landscapes. Rupert is the son of Wenshuo Li and Zhu Wang. He attends **Jesuit High School** where he has enjoyed the science bowl team and Zero Robotics club, leads the regional math league teams, and performs in the chamber choir.

2020 FINALISTS

Jason Liu

The Davidson Academy of Nevada
Nevada

Jason Jiming Liu, 17, of **Reno**, advanced the study of q-integer polynomials for his Regeneron Science Talent Search **mathematics** project. Integer polynomials are algebraic expressions, such as ½ x^2 + ½x, in which an integer (whole number) value for x produces an integer output. Jason worked with q-integer polynomials, a generalization where every q-integer input is itself a polynomial in q. These polynomials are very abstract, but Jason was able to find a "basis" for these q-polynomials. In mathematics, the term basis is an especially useful representation that is as small as possible, but contains all possible information. Previous work had found a basis for polynomials which sent positive q-integer inputs to polynomials in q, but Jason was able to extend this to cases which also sent negative q-integers to polynomials in q-1, and even to q-integer polynomials with more than one variable. Jason hopes that his work will help scientists better understand quantum mechanics. Jason attends **Davidson Academy** where he heads the math club. A passionate pianist since the age of four, he placed first in ensemble piano and second in both concerto and social solo piano at the Silver State Piano Competition. He is the son of Nengzhi Jiang and Guofeng Liu.

Kyra McCreery

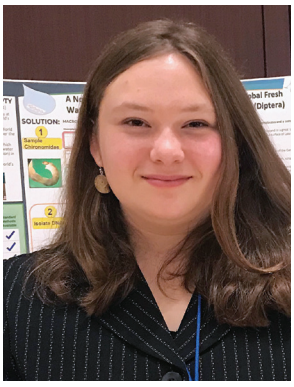
North Shore High School
New York

Kyra McCreery, 17, of **Sea Cliff**, studied the slowing translation speed and increasing precipitation of North Atlantic tropical storms for her Regeneron Science Talent Search **environmental science** project. Hoping to explore a possible link between climate change and a slowdown in cyclone or hurricane translation (ground) speed in the North Atlantic, Kyra analyzed data from 1,857 tropical cyclones that have occurred between 1851 and 2016. Her research suggests that their average translation speeds have declined considerably over the past 165 years, while their frequency and intensity appear to have increased. She concluded that the effects of climate change may cause these storms to stall more often, thus increasing their severity, accumulated precipitation and resulting large-scale flooding. At **North Shore High School** in Glen Head, Kyra is assistant editor-in-chief and head science writer for the school newspaper. Kyra's parents are Margaret Franck and James McCreery. She is a passionate volunteer with HorseAbility, an equine therapy facility for people with special needs. Kyra helps with therapy sessions and riding programs, leads volunteer training sessions, and assists with onsite riding competitions.

Nadine Meister

Centennial High School
Maryland

Nadine Meister, 17, of **Ellicott City**, submitted a Regeneron Science Talent Search project focused on the theoretical **chemistry** of glasslike materials called supercooled liquids with applications for metallic glasses. Metallic glasses are metals that have a molecular arrangement similar to glass, giving them physical properties that make them appealing for a wide range of real-world applications. They are formed from liquids cooled below their freezing point (supercooled) using a precise process to ensure that they remain fluid. A sound theoretical understanding of supercooled liquids is essential for engineers to use them effectively. Nadine modeled supercooled liquids by applying Wilson's renormalization group technique, a method developed to explain the nature of liquids near equilibrium with their gaseous phase, to several traditional models. Her innovative approach provided new insights on how the physical and thermodynamic properties of these materials relate to one another. At **Centennial High School**, Nadine is co-captain of the Math Team and founded a club that teaches programming to peers. A talented musician, Nadine has performed piano at Carnegie Hall. Her parents are Wenge Ni-Meister and Gerhard Meister.



Sonja Michaluk

Hopewell Valley Central High School
New Jersey

Sonja Morgan Simon Michaluk, 16, of **Titusville**, used her Regeneron Science Talent Search **environmental science** project to develop a precise, biology-based method to measure the health of surface water on which world populations rely. Sonja used DNA barcoding of larval samples of the globally present Chironomidae family of non-biting midge. She found that using the fly's DNA sequence captures the cumulative effects of habitat alteration and pollutants that are missed by standard methods of monitoring, such as chemical testing and field sensors. She also designed a statistical sampling plan to represent variations in geological, ecological and land use factors. Sonja's scalable, replicable method is less vulnerable to human error and improves on existing bioassessment techniques that require costly, time-consuming manual taxonomic expertise. Her work could help spur development of a global protocol for freshwater assessment. Sonja attends **Hopewell Valley Central High School** in Pennington. A science educator, scuba diver and sailing instructor, Sonja's research and advocacy influenced her Town Council to preserve 20 acres of ecologically critical wetlands. Sonja is the daughter of Aaron and Selina Michaluk.

2020 FINALISTS

Arjun R Neervannan

University High School
California

Arjun R Neervannan, 17, of **Irvine**, completed a **behavioral and social sciences** project for the Regeneron Science Talent Search with AI software designed to identify hateful or toxic content, often a method of cyberbullying, with less bias than current programs. Built-in bias that associates racial, gender and other identity terms with toxicity can lead to inappropriate censoring of productive discussions. His neural network incorporated several new features including a "debiasing element," a dataset expanded with counter examples containing the identity terms. Then he trained his model on over 99,000 online comments. Arjun believes his scalable, automated debiasing process produces a more accurate and fair AI model. Written for forums in English, his model could be expanded to other languages. At **University High School**, Arjun is president of the technology student association, holding regular meetings and workshops on AI, robotics, CAD and Arduino. He also helped form an all-girls robotics team in Nigeria, the first of its kind in West Africa. The son of Aruna and Rajmohan Neervannan, Arjun is a passionate Carnatic violinist and has given many concerts, including a 3.5-hour duet with his brother in 2018.

Annie Ostojic

Munster High School
Indiana

Ann Marie Ostojic, 17, of Munster, investigated the unstudied function of the gene *CCDC191* and the role it might play in the development or progression of cancer for her Regeneron Science Talent Search **computational biology and bioinformatics** project. Annie's study utilized a public access database to study gene *CCDC191* in 33 cancer types before narrowing her focus to human breast cancer. Her novel approach used AI deep learning and reverse engineering mathematical modeling to conduct computer analyses of differential gene expression and patient survival. She found that the gene acts as a double agent and can lead to either the loss of controlled cell death or uncontrolled cell growth, both of which contribute to cancer development depending on the cancer type or mechanism. She believes her study presents a replicable model to streamline identification of gene function. The daughter of Diane and Ronald Ostojic, Annie attended **Munster High School**. She tutors students for free, and was recently selected as the only student member of Indiana's STEM Advisory Committee. Annie holds two provisional patents, and attended the White House Science Fair as a middle school student.

Lillian Kay Petersen

Los Alamos High School
New Mexico

Lillian Kay Petersen, 17, of **Los Alamos**, used her Regeneron Science Talent Search **environmental science** project to devise a tool to predict harvests early in the growing season with the goal of using it in developing countries where poor monitoring practices can delay responses to drought and food shortages. Aware of the lifelong consequences of malnutrition thanks to the experiences her adopted siblings encountered in their former homes, Lillian focused on reducing food insecurity. Her forecasting method, which she first validated on known crop data for Illinois, analyzes daily satellite imagery using globally accepted measures of relative vegetation health. She then used her system to accurately predict crop yields for a recent year in every country in Africa, with a median error of only 8.6 percent compared to actual harvests for the same year. Lillian's work is published in the journal *Remote Sensing* and she has presented her real-time forecasting tool at seminars to global aid and crop health organizations, including USAID and USDA. She attends **Los Alamos High School** where she leads the Eco Club and is a dedicated cross country runner. The daughter of Kimberly and Mark Petersen, Lillian also plays and teaches violin.

Alina Virginia Pollner

Canyon Crest Academy
California

Alina Virginia Pollner, 18, of **San Diego**, investigated the role of a subset of two regulatory genes referred to as *Mini Zinc Fingers (MZF)* in *Arabidospsis thaliana*, a plant in the mustard family, for her Regeneron Science Talent Search **plant sciences** project. The gene *MZF1* is highly expressed in fruit and flowers at early stages. Alina used CRISPR Cas9, a technique that uses "molecular scissors" to edit DNA, to delete two MZF genes. She found that mustard plants with both the *MZF1* and *MZF2* genes removed had a 295 percent increase in fruit per stem. Mutant plants with only the *MZF1* gene "knocked out" produced 87 percent more fruit than wild type plants, but *MZF2* knock-out plants showed no significant increase in fruit production. She believes her research could help reduce food insecurity through the ability to grow more food in the same amount of space. The daughter of Erika and Reinhold Pollner, Alina attends **Canyon Crest Academy** where she is president of the Society of Women Engineers and Science Fair Buddies, a group that mentors underserved middle school students. A runner and triathlete, Alina is an assistant coach of Girls on the Run, a program dedicated to helping elementary school girls build confidence and character through running.

2020 FINALISTS

Katherine St George

John F. Kennedy High School
New York

Katherine June St George, 17, of **Merrick**, studied the concurrent impact of diet and caffeine on seizure susceptibility using fruit flies as an epilepsy model for her Regeneron Science Talent Search **animal sciences** project. Previously, a high-fat, low-carbohydrate ketogenic diet had been shown to reduce seizures caused by imbalances in the neurotransmitters, glutamate and gamma-aminobutyric acid, while caffeine had been shown to increase them. Katherine's flies were raised on different diets, exposed to caffeine in varying amounts and "shocked" using a vortex mixer to induce seizures. She recorded the results on a mobile phone camera and observed during her analysis that ketogenic diets counteract the effect of caffeine on seizures and may safeguard against glutamate-promoter-induced seizures. At **John F. Kennedy High School** in Bellmore, Katherine is the president of the Helping Our Planet Earth Club and the Gay-Straight Alliance. She founded her school's first clothing drive to support transgender people, tutors elementary school students, plays the clarinet, and participates in Science Olympiad. Katherine is the daughter of Nenad and Tatjana St George.

Anaiah Bre Thomas

Bergen County Academies
New Jersey

Anaiah Bre Thomas, 18, of Teaneck, investigated the origin of $CD56^{bright}$ and $CD56^{dim}$ natural killer (NK) cells and how they are influenced by the microenvironment of cancers for her Regeneron Science Talent Search **medicine and health** project. NK cells are immune cells that defend the body against infection and cancer. $CD56^{bright}$ NK cells prevent $CD56^{dim}$ NK cells from attacking healthy native tissue. To test theories regarding the differentiation of these cell types, Anaiah cultured $CD56^{bright}$ and $CD56^{dim}$ together with cancer-derived fibroblast cells that can bind to NK cells and stimulate changes in their function. She found that the cells can switch from one type to the other based on their microenvironment. Anaiah believes her research could one day aid development of cancer and autoimmune therapies. Anaiah attends **Bergen County Academies** in Hackensack. The daughter of LeToya Freeman and Corey Thomas, she is an EMT and has assisted with CPR and delivering a baby. As a student leader, Anaiah raised nearly $500,000 for climate justice organization Zero Hour. Anaiah is the editor of the school newspaper, works at a local ice cream shop, and researches presidential candidates as part of an internship.

Adriane Elizabeth Thompson

The Wellington School
Ohio

Adriane Elizabeth Thompson, 17, of **Westerville**, identified new regulatory genetic pathways in corn plants for her Regeneron Science Talent Search cellular and **molecular biology** project. She focused on one of the many pathways that use enzymes, in this case RNA Polymerase IV, to turn off certain genes without changing their genetic code. Using a quantitative laboratory technique to measure levels of gene expression and note where those levels changed, Adriane determined which genes do not need RNA Polymerase IV, implying that they fall under novel pathways that regulate gene repression. Adriane's contribution to understanding the complex genetic makeup of corn may help to determine growth factors and predict agricultural outcomes for this important crop. She attends **The Wellington School** in Columbus where she is president of Model U.N., a leader in Ohio Youth in Government and a founding member of the debate team at her school. Adriane has also been a lead volunteer with the Center of Science and Industry museum, and is an accomplished dancer who frequently performs with a professional dance company. She is the daughter of Jeffrey Thompson and Susan Cole.

Rohan Mahesh Wagh

Sunset High School
Oregon

Rohan Mahesh Wagh, 17, of **Portland**, developed a bacteria-powered sensor system to measure soil conductivity, thus minimizing water waste for more effective irrigation and increasing crop yields, as his Regeneron Science Talent Search **engineering** project. Rohan's design used microbial fuel cell modules as sensors that can be distributed in farm fields during the growing season, wirelessly providing up-to-date measurements of soil moisture and nutrient conditions to farmers. An algorithm he wrote interprets the soil data to generate a map of the conditions reported by each sensor. Rohan's sensor design could be installed at the start of the growing season for around $100 per acre, providing readings throughout the year, as opposed to current labor-intensive techniques which are temporary and significantly more expensive. A champion varsity racquetball player at **Sunset High School**, Rohan has also received accolades as part of the robotics team and for his talents as a pianist. As a result of his service on the March for Science steering committee and two local government advisory boards, he was named Grand Marshal of the 125th Anniversary Parade for the City of Beaverton. His parents are Mahesh Wagh and Mallika Kapoor.

2020 FINALISTS

Ella Rose Wesson

Manhasset High School
New York

Ella Rose Wesson, 17, of **Manhasset**, used gas-filled balloons and holography to investigate methods of evaluating acoustic materials for her Regeneron Science Talent Search **physics** project. Foregoing expensive micro-scale materials, Ella filled spherical and cylindrical latex balloons with helium (one third as dense as air) and sulfur hexafluoride (three times as dense as air). Sound waves passing from air into the helium filled balloon diverged, while the balloon filled with denser sulfur hexafluoride made the waves converge, like lenses do for light. She then used photographic images of the sound waves, called acoustic holograms, to show how sound waves propagate through an array of these balloons, demonstrating that her approach could potentially be used to model the performance of new acoustic materials. Ella believes her work will make it easier to test new ways to enhance, suppress and use sound waves. The daughter of Jonathan and Karen Wesson, Ella attends **Manhasset High School** where she co-captains the varsity swim and dive team and edits the school newspaper. Ella plays first flute and piccolo for the Metropolitan Youth Orchestra and has worked as a volunteer, helping to set up ear-screening clinics in South Africa

Alek M. Westover

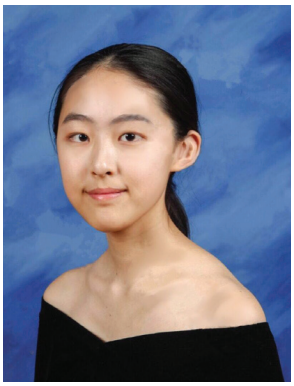
Belmont High School
Massachusetts

Alek Michael Westover, 17, of **Belmont**, developed a parallel partition algorithm for his **computer science** submission to the Regeneron Science Talent Search that improves on four previously developed algorithms. Every task a computer performs depends on the sorting and assignment of data into a memory location, which is not a trivial undertaking. In fact, the order in which variables are sorted and the means by which they are arranged in a computer's memory while tasks are performed can greatly impact the overall speed of calculations. Alek created the Smoothed Striding Algorithm to improve the efficiency of this process. His method introduces randomization to out-perform previously developed algorithms of the same type. Alek's creation is also well suited to analysis that accurately predicts its performance given an arbitrary set of inputs, an important concern for programmers. The son of Emily and Michael Westover, Alek studies piano and is an Eagle Scout, an achievement he credits with helping him "develop grit to accomplish hard things." Alek attends **Belmont High School** where he is founding president of the Hackathon Club and captain of the math team. He also works part time at a healthcare AI startup.

Brian Y. Wu

Horace Mann School
New York

Brian Yikang Wu, 18, of **Scarsdale**, developed an innovative approach to identify and confirm circumbinary exoplanets (planets that orbit two stars) for his Regeneron Science Talent Search **space science** project. Brian examined existing spectra from 1,100 sun-like stars using Doppler spectroscopy to look for "spectra wobbles," which indicate the possibility of an orbiting planet. He then analyzed his findings using a novel combination of open source software and a deep learning program he developed to both reduce errors from the original dataset and further refine his results. Brian's neural network method showed improved accuracy of exoplanet identification over current methods, and he successfully identified a new circumbinary planet. Brian hopes his efforts may aid in the identification of habitable planets outside our solar system and also contribute to the development of sustainable space travel. The son of Wei Zhou and Xin Wu, Brian attends **Horace Mann School** in the Bronx and is the founder and CEO of a startup company that improves designs for rocket engines and propulsion technologies. He has presented his exoplanet research at NASA headquarters, has given a TEDx talk, and is the current managing editor for his school's quarterly science magazine.



Yi Xie

Bronx High School of Science
New York

Yi (Eva) Xie, 18, of **Flushing**, used her Regeneron Science Talent Search **genomics** project to identify single nucleotide polymorphisms (SNP), or genetic variations, that show tolerance to the toxic side effects of cardiac glycosides (CG), a steroid therapy currently used to treat cardiovascular diseases. This work, which explores the genetic basis of steroid tolerance, may, one day, advance drug development for personalized medicine and help to overcome medical limitations of current treatment for cardiovascular diseases, the foremost cause of death worldwide. Applying computational methods of comparative functional genetics, Eva performed genetic association studies exposing 30 fruit fly strains to CGs. Her results revealed four SNPs associated with adult fruit fly survival. A student at **Bronx High School of Science**, Eva is founder of the STEM-related DIY club, co-founder of her school's physical science journal and director of marketing/graphics for TeenHacks LI, the largest 24-hour high school hackathon in Long Island. She also volunteers as a family physician assistant in a local medical clinic. The daughter of Jingyan Zhang and Haifeng Xie, Eva produces digital art that encourages interest in science and nature.

2020 FINALISTS

Ellie Yang

Parkway Central High School
Missouri

Ellie Zhixi Yang, 17, of **Chesterfield**, submitted a **computer science** project to the Regeneron Science Talent Search for a deep learning computer vision model designed to detect guns, knives and blood from streaming videos – a project inspired by the school shooting in Parkland, Florida. Her ultimate goal was to facilitate faster emergency responses to save lives. Ellie trained her "SafetyNet" computer vision system to detect weapons and violence from live video using 3.7 million pieces of human-annotated digital image data. In operation, the system is designed to analyze video from social media or onsite streaming systems and return results fast, in under 100 milliseconds. A key part of her labor was her upfront effort to annotate the large dataset with the words "guns," "knives" and "blood," a process that required many hours and powered the several iterations of her model. Ellie believes her product is 400 percent more accurate than commercially available software. At **Parkway Central High School**, Ellie heads the Science Olympiad team and captains her varsity golf team that placed first in its conference for two years. She also plays first violin with the St. Louis Symphony Youth Orchestra. Ellie's parents are Hong Chen and Heping Yang.

Kevin G. Yang

Fairview High School
Colorado

Kevin G. Yang, 18, of **Boulder**, submitted a **materials science** project to the Regeneron Science Talent Search seeking to increase greenhouse yield by creating a new film to filter sunlight. The new material contains a fluorescent dye that converts the green light, which is not used efficiently by plants, into red light that plants absorb to drive photosynthesis. Unlike an ordinary red film that would trap the red light within it, Kevin incorporated LED-inspired microstructures into his film to make more photosynthetic light available to the growing plants. In small-scale growth tests, he showed that the new film increased the photosynthetic rate of single celled algae by over 30 percent. He hopes future research will contribute to more efficient greenhouses to help feed ever-growing human populations. At **Fairview High School**, Kevin founded the physics club and leads the Science Bowl team. He serves on the teen board of the annual Boulder Creek Festival, and spends every Sunday teaching an interactive math class to foster the problem-solving passion of more than 30 elementary school students. Kevin is the son of Ronggui Yang and Jane Zheng.

Jake Yasonik

Homestead High School
Wisconsin

Jacob Yasonik, 18, of **Mequon**, created a computer-based system that he hopes will improve the process of drug discovery for his Regeneron Science Talent Search **computational biology and bioinformatics** project. Working from home, Jake combined a recurrent neural network with a special sorting algorithm to create a cycle for developing and optimizing molecules "from scratch." This computational approach uses theoretical knowledge to identify molecular structures with desired characteristics (one such example could be generating and identifying molecules targeting malaria). This method of drug development comes with practical challenges because a particular computer-generated structure may not be easily synthesized or it might lack the desired chemical properties. Compared to existing methods, Jake says his approach yielded a 14-fold increase in the number of molecules generated with all of the desired chemical properties. An award-winning pianist, he has soloed at Carnegie Hall. At **Homestead High School**, Jake is a cofounder of a state student research group, and he enjoys card stacking, juggling, chess, magic and calligraphy. The son of Aleksandr and Viktoriya Yasonik, he ran the 2018 Chicago half-marathon.

Zhifei Yu

Phillips Academy
Massachusetts

Zhifei (Faye) Yu, 18, of **Andover**, submitted a **space science** project to the Regeneron Science Talent Search describing the orbital decay of a binary system called LMC X-4 that consists of a tiny X-ray-emitting star and a giant star both orbiting around their mutual center of mass. Faye analyzed new data from a NASA satellite to determine the absolute date and time at which the giant star eclipses the small star and added her data to historical measurements. Using the results, she calculated the rate at which the orbit of the two stars is decaying, obtaining results ten times more precise than previous results. She went on to deduce two more properties of the star system, the distance between the two stars and the system's total energy. Faye concluded that the stars' constantly decaying orbit will cause the two eventually to merge, with the small star residing within the giant star. Faye heads the astronomy and physics clubs at **Phillips Academy**, plays tennis, and is a board member and coach of the Public Forum Debate Club. The daughter of Xiangdong Yu and Hong Ding, Faye says her proudest accomplishment was summiting Mount Kilimanjaro in Africa. She composes music in her spare time.

REGENERON SCIENCE TALENT SEARCH 2020 | Finalists by State

REGENERON SCIENCE TALENT SEARCH 2020 | Finalists by Last Name

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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 Regeneron 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.

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About Regeneron

Regeneron is a leading biotechnology company that invents life-transforming medicines for people with serious diseases. Founded and led for more than 30 years by physician-scientists, our unique ability to repeatedly and consistently translate science into medicine has led to seven FDA-approved treatments and numerous product candidates in development, 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, infectious diseases, pain and rare diseases.

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